# ZOONOMI

2222

OR,

## THE LAWS

OF

## ORGANIC LI

IN FOUR VOLUMES.

*By ERASMUS DARWIN, M.D. F.*

AUTHOR OF THE BOTANIC GARDEN.

Principiò cœlum, ac terras, camposque liquentes,
Lucentemque globum lunæ, titaniaque astra,
Spiritus intùs alit, totamque infusa per artus
Mens agitat molem, et magno se corpore miscet.

VIRG. ÆN. vi.

Earth, on whose lap a thousand nations tread,
And Ocean, brooding his prolific bed,
Night's changeful orb, blue pole, and silvery zones,
Where other worlds encircle other suns,
One mind inhabits, one diffusive Soul
Wields the large limbs, and mingles with the whole.

## VOL. I.

*THE THIRD EDITION, CORRECTED.*

LONDON:

PRINTED FOR J. JOHNSON, IN ST. PAUL'S CHURCH-YARD.

1801.

*T. Bensley, Printer, Bolt Court, Fleet Street.*

222
2189

# DEDICATION.

To the candid and ingenious Members of the College of Physicians, of the Royal Philosophical Society, of the Two Universities, and to all those, who study the Operations o the Mind as a Science, or who practise Medicine as a Profession, the subsequent Work is, with great respect, inscribed by the Author.

Derby, May 1, 1794.

ſpread hands the boſom's velvet orbs,
ng lips the milky fount abſorbs;
mpreſs'd the dulcet ſtreams diſtil,
mth and fragrance from the living rill;—
mute rapture every waving line,
rint ith adoring kiſs the Paphian ſhrine,
And learns ere long, the perfect form confeſs'd,
Ideal Beauty from its mother's breaſt.
Now in ſtrong lines, with bolder tints deſign'd,
You ſketch ideas, and portray the mind;
Teach how fine atoms of impinging light
To ceaſeleſs change the viſual ſenſe excite:
While the bright lens collects the rays, that ſwerve,
And bends their focus on the moving nerve.
How thoughts to thoughts are link'd with viewleſs chains,
Tribes leading tribes, and trains purſuing trains;
With ſhadowy trident how Volition guides,
Surge after ſurge, his intellectual tides;
Or, Queen of Sleep, Imagination roves
With frantic Sorrows, or delirious Loves.
Go on, O FRIEND! explore with eagle-eye;
Where wrapp'd in night retiring Cauſes lie:
Trace their ſlight bands, their ſecret haunts betray,
And give new wonders to the beam of day;
Till, link by link with ſtep aſpiring trod,
You climb from NATURE to the throne of GOD.
——So ſaw the Patriarch with admiring eyes
From earth to heaven a golden ladder riſe;
Involv'd in clouds the myſtic ſcale aſcends,
And brutes and angels crowd the diſtant ends.

TRIN. COL. CAMBRIDGE, *Jan.* 1, 1794.

## REFERENCES.

*Botanic Garden*, Part I.

Line 1. Canto I. l. 105.
—— 3. —— IV. l. 402.
—— 4. —— I. l. 140.
—— 5. —— III. l. 401.
—— 8. —— IV. l. 452.
—— 9. —— I. l. 14.

*Zoonomia.*

—— 12. Sect. XIII.
—— 13. —— XXXIX. 4. 1.

Line 18. Sect. XVI. 2. and XXXVIII.
—— 26. —— XVI. 4.
—— 30. —— XVI. 4.
—— 36. —— XVI. 6.
—— 38. —— III. and VII.
—— 43. —— X.
—— 44. —— XVIII. 17.
—— 45. —— XVII. 3. 7.
—— 47. —— XVIII. 8.
—— 50. —— XXXIX. 4. 8.
—— 51. —— XXXIX. the Motto.
—— 54. —— XXXIX. 8.

# PREFACE.

THE purport of the following pages is an endeavour to reduce the facts belonging to ANIMAL LIFE into claſſes, orders, genera, and ſpecies; and, by comparing them with each other, to unravel the theory of diſeaſes. It happened, perhaps unfortunately for the inquirers into the knowledge of diſeaſes, that other ſciences had received improvement previous to their own; whence, inſtead of comparing the properties belonging to animated nature with each other, they, idly ingenious, buſied themſelves in attempting to explain the laws of life by thoſe of mechaniſm and chemiſtry; they conſidered the body as an hydraulic machine, and the fluids as paſſing through a ſeries of chemical changes, forgetting that animation was its eſſential characteriſtic.

The great CREATOR of all things has infinitely diverſified the works of his hands, but has at the ſame time ſtamped a certain ſimilitude on the features of nature, that demonſtrates to us, that *the whole is one family of one parent.* On this ſimilitude is founded all rational analogy; which, ſo long as it is concerned in comparing the eſſential properties of bodies, leads us to many and

important discoveries; but when with licentious activity it links together objects, otherwise discordant, by some fanciful similitude; it may indeed collect ornaments for wit and poetry, but philosophy and truth recoil from its combinations.

The want of a theory, deduced from such strict analogy, to conduct the practice of medicine is lamented by its professors; for, as a great number of unconnected facts are difficult to be acquired, and to be reasoned from, the art of medicine is in many instances less efficacious under the direction of its wisest practitioners; and by that busy crowd, who either boldly wade in darkness, or are led into endless error by the glare of false theory, it is daily practised to the destruction of thousands; add to this the unceasing injury which accrues to the public by the perpetual advertisements of pretended nostrums; the minds of the indolent become superstitiously fearful of diseases, which they do not labour under; and thus become the daily prey of some crafty empyric.

A theory founded upon nature, that should bind together the scattered facts of medical knowledge, and converge into one point of view the laws of organic life, would thus on many accounts contribute to the interest of society. It would capacitate men of moderate abilities to practise the art of healing with real advantage to the public; it would enable every one of literary

acquirements

acquirements to diſtinguiſh the genuine diſciples of medicine from thoſe of boaſtful effrontery, or of wily addreſs; and would teach mankind in ſome important ſituations the *knowledge of themſelves.*

There are ſome modern practitioners, who declaim againſt medical theory in general, not conſidering that to think is to theorize; and that no one can direct a method of cure to a perſon labouring under diſeaſe without thinking, that is, without theorizing; and happy therefore is the patient, whoſe phyſician poſſeſſes the beſt theory.

The words idea, perception, ſenſation, recollection, ſuggeſtion, and aſſociation, are each of them uſed in this treatiſe in a more limited ſenſe than in the writers of metaphyſic. The author was in doubt, whether he ſhould rather have ſubſtituted new words inſtead of them; but was at length of opinion, that new definitions of words already in uſe would be leſs burthenſome to the memory of the reader.

A great part of this work has lain by the writer above twenty years, as ſome of his friends can teſtify: he had hoped by frequent reviſion to have made it more worthy the acceptance of the public; this however his other perpetual occupations have in part prevented, and may continue to prevent, as long as he may be capable of reviſing it; he therefore begs of the candid reader to accept of it in its preſent ſtate, and to excuſe

any

any inaccuracies of expreffion, or of conclufion, into which the intricacy of his fubject, the general imperfection of language, or the frailty he has in common with other men, may have betrayed him; and from which he has not the vanity to believe this treatife to be exempt.

# PREFACE

TO

# THE THIRD EDITION.

The Reader ſhould be apprized, that many new pages are interſperſed in this edition, which conſiſt of practical and theoretical obſervations, as the whole articles on Hemicrania idiopathica, retroverſio uteri, aneuriſma, and the appendix to the ſection on Generation, beginning at No. 8. as well as the diſtinction between philoſophy and ſophiſtry in Sect. XV. 1. 5. and the Ratiocinatio verboſa, verbal reaſoning, in Claſs III. 2. 2. 3. and ſome others.

Derby, Jan. 1, 1801.

In the former editions of this work the Materia Medica was placed after the ſecond part, or the claſſes of diſeaſes, but, to preſerve the more equal ſize of the volumes, in this octavo edition, the publiſher has placed it, with the aſſent of the author, after the firſt part.

CONTENTS.

# CONTENTS.

Preface.
SECT. I. Of Motion.
II. Explanations and Definitions.
III. The Motions of the Retina demonstrated by Experiments.
IV. Laws of Animal Causation.
V. Of the four Faculties or Motions of the Sensorium.
VI. Of the four Classes of Fibrous Motions.
VII. Of Irritative Motions.
VIII. Of Sensitive Motions.
IX. Of Voluntary Motions.
X. Of Associate Motions.
XI. Additional Observations on the Sensorial Powers.
XII. Of Stimulus, Sensorial Exertion, and Fibrous Contraction.
XIII. Of Vegetable Animation.
XIV. Of the Production of Ideas.
XV. Of the Classes of Ideas.
XVI. Of Instinct.
XVII. The Catenation of Animal Motions.
XVIII. Of Sleep.
XIX. Of Reverie.
XX. Of Vertigo.
XXI. Of Drunkenness.
XXII. Of Propensity to Motion. Repetition. Imitation.
XXIII. Of the Circulatory System.
XXIV. Of the Secretion of Saliva, and of Tears. And of the Lacrymal Sack.
XXV. Of the Stomach and Intestines.
XXVI. Of the Capillary Glands, and of the Membranes.
XXVII. Of Hæmorrhages.
XXVIII. The Paralysis of the Lacteals.
XXIX. The Retrograde Motions of the Absorbent Vessels.

ZOONOMIA.

# ZOONOMIA;

OR,

# THE LAWS OF ORGANIC LIFE.

## PART I.

CONTAINING

THE IMMEDIATE CAUSES OF ANIMAL MOTIONS,

DEDUCED FROM

THEIR MORE SIMPLE OR FREQUENT APPEARANCES IN HEALTH,

AND APPLIED TO EXPLAIN

THEIR MORE INTRICATE OR UNCOMMON OCCURRENCES IN DISEASES.

*Felix, qui potuit rerum cognoſcere cauſas.*

## ERRATUM.

The two lines quoted in Section XXXIX. Vol. II. page 296, are from Ausonius, Epig. 105, and should have been

Dum dubitat Natura marem, faceretne puellam
Factus es, O pulcher, pene puella, Puer!

# ZOONOMIA.

## SECT. I.

### OF MOTION.

THE WHOLE OF NATURE may be ſuppoſed to conſiſt of two eſſences or ſubſtances; one of which may be termed ſpirit, and the other matter. The former of theſe poſſeſſes the power to commence or produce motion, and the latter to receive and communicate it. So that motion, conſidered as a cauſe, immediately precedes every effect; and conſidered as an effect, it immediately ſucceeds every cauſe. And the laws of motion therefore are the laws of nature.

The MOTIONS OF MATTER may be divided into two kinds, primary and ſecondary. The ſecondary motions are thoſe, which are given to or received from other matter in motion. Their laws have been ſucceſsfully inveſtigated by philoſophers in their treatiſes on mechanic powers. Theſe motions are diſtinguiſhed by this circumſtance, that the velocity multiplied into the quantity of matter of the body acted upon is equal to the velocity multiplied into the quantity of matter of the acting body.

The primary motions of matter may be divided into three classes, those belonging to gravitation, to chemistry, and to life; and each class has its peculiar laws. Though these three classes include the motions of solid, liquid, and aerial bodies; there is nevertheless a fourth division of motions; I mean those of the supposed ethereal fluids of magnetism, electricity, heat, and light; whose properties are not so well investigated as to be classed with sufficient accuracy.

*1st.* The gravitating motions include the annual and diurnal rotation of the earth and planets, the flux and reflux of the ocean, the descent of heavy bodies, and other phænomena of gravitation. The unparalleled sagacity of the great NEWTON has deduced the laws of this class of motions from the simple principle of the general attraction of matter: to which should perhaps be added the general repulsion of matter; which seems to have caused the projection of the planets from the sun, and to prevent their relapse into one chaotic mass. These motions are distinguished by their tendency to or from the centres of the sun or planets.

*2d.* The chemical class of motions includes all the various appearances of chemistry. Many of the facts, which belong to these branches of science, are nicely ascertained, and elegantly classed; but their laws have not yet been developed from such simple principles as those above mentioned;

mentioned; though it is probable, that they depend on the ſpecific attractions belonging to the particles of bodies, or to the difference of the quantity of attraction belonging to the ſides and angles of thoſe particles, to which ſhould perhaps be added the ſpecific repulſions belonging to the particles of bodies. When theſe repulſions prevail over the attractions, they may cauſe the diffuſions of light and of odours, the exploſions of ſome bodies, and the ſlower decompoſition of others, and occaſion our ideas of fluidity; when the attractions prevail over the repulſions, they may cauſe the ſtricter combinations and coheſions of matter, as in cryſtallization or cooling, and give riſe to our ideas of ſolidity; and when theſe two cauſes of motion are in active equilibrium, they may produce the vibrations of the particles of bodies, and occaſion our ideas of ſound. The chemical motions are diſtinguiſhed by their being generally attended with an evident decompoſition or new combination of the active materials.

3*d*. The third claſs includes all the motions of the animal and vegetable world; as well thoſe of the veſſels, which circulate their juices, and of the muſcles, which perform their locomotion, as thoſe of the organs of ſenſe, which conſtitute their ideas.

This laſt claſs of motion is the ſubject of the following pages; which, though conſcious of

their many imperfections, I hope may give some pleasure to the patient reader, and contribute something to the knowledge and to the cure of diseases.

SECT.

## SECT. II. 1.

### EXPLANATIONS AND DEFINITIONS.

I. *Outline of the animal economy.*—II. 1. *Of the ſenſorium.* 2. *Of the brain and nervous medulla.* 3. *A nerve.* 4. *A muſcular fibre.* 5. *The immediate organs of ſenſe.* 6. *The external organs of ſenſe.* 7. *An idea or ſenſual motion.* 8. *Perception.* 9. *Senſation.* 10. *Recollection and ſuggeſtion.* 11. *Habit, cauſation, aſſociation, catenation.* 12. *Reflex ideas.* 13. *Stimulus defined.*

---

As ſome explanations and definitions will be neceſſary in the proſecution of the work, the reader is troubled with them in this place, and is intreated to keep them in his mind as he proceeds, and to take them for granted, till an apt opportunity occurs to evince their truth; to which I ſhall premiſe a very ſhort outline of the animal economy.

---

I.—1. THE nervous ſyſtem has its origin from the brain, and is diſtributed to every part of the body. Thoſe nerves, which ſerve the ſenſes, principally ariſe from that part of the brain, which is lodged in the head; and thoſe, which ſerve the purpoſes of muſcular motion, principally ariſe from that part of the brain, which is lodged in

the neck and back, and which is erroneoufly called the fpinal marrow. The ultimate fibrils of thefe nerves terminate in the immediate organs of fenfe and mufcular fibres, and if a ligature be put on any part of their paffage from the head or fpine, all motion and perception ceafe in the parts beneath the ligature.

2. The longitudinal mufcular fibres compofe the locomotive mufcles, whofe contractions move the bones of the limbs and trunk, to which their extremities are attached. The annular or fpiral mufcular fibres compofe the vafcular mufcles, which conftitute the inteftinal canal, the arteries, veins, glands, and abforbent veffels.

3. The immediate organs of fenfe, as the retina of the eye, probably confift of moving fibrils, with a power of contraction fimilar to that of the larger mufcles above defcribed.

4. The cellular membrane confifts of cells, which refemble thofe of a fponge, communicating with each other, and connecting together all the other parts of the body.

5. The arterial fyftem confifts of the aorta and the pulmonary artery, which are attended through their whole courfe with their correfpondent veins. The pulmonary artery receives the blood from the right chamber of the heart, and carries it to the minute extenfive ramifications of the lungs, where it is expofed to the action of the air on a furface equal to that of the whole external fkin,

through

through the thin moiſt coats of thoſe veſſels, which are ſpread on the air-cells, which conſtitute the minute terminal ramifications of the windpipe. Here the blood changes its colour from a dark red to a bright ſcarlet. It is then collected by the branches of the pulmonary vein, and conveyed to the left chamber of the heart.

6. The aorta is another large artery, which receives the blood from the left chamber of the heart, after it has been thus aerated in the lungs, and conveys it by aſcending and deſcending branches to every part of the ſyſtem; the extremities of this artery terminate either in glands, as the ſalivary glands, lachrymal glands, &c. or in capillary veſſels, which are probably leſs involuted glands; in theſe ſome fluid, as ſaliva, tears, perſpiration, is ſeparated from the blood; and the remainder of the blood is abſorbed or drank up by branches of veins correſpondent to the branches of the artery; which are furniſhed with valves to prevent its return; and is thus carried back, after having again changed its colour to a dark red, to the right chamber of the heart. The circulation of the blood in the liver differs from this general ſyſtem; for the veins which drink up the refluent blood from thoſe arteries, which ſpread on the bowels and meſentery, unite into a trunk in the liver, and form a kind of artery, which is branched into the whole ſubſtance of the liver, and is called the vena portarum; and

from which the bile is ſeparated by the numerous hepatic glands, which conſtitute that viſcus.

7. The glands may be divided into three ſyſtems, the convoluted glands, ſuch as thoſe above deſcribed, which ſeparate bile, tears, ſaliva, &c. Secondly, the glands without convolution, as the capillary veſſels, which unite the terminations of the arteries and veins; and ſeparate both the mucus, which lubricates the cellular membrane, and the perſpirable matter, which preſerves the ſkin moiſt and flexible. And thirdly, the whole abſorbent ſyſtem, conſiſting of the lacteals, which open their mouths into the ſtomach and inteſtines, and of the lymphatics, which open their mouths on the external ſurface of the body, and on the internal linings of all the cells of the cellular membrane, and other cavities of the body.

Theſe lacteal and lymphatic veſſels are furniſhed with numerous valves to prevent the return of the fluids, which they abſorb, and terminate in glands, called lymphatic glands, and may hence be conſidered as long necks or mouths belonging to theſe glands. To theſe they convey the chyle and mucus, with a part of the perſpirable matter, and atmoſpheric moiſture; all which, after having paſſed through theſe glands, and having ſuffered ſome change in them, are carried forward into the blood, and ſupply perpetual nouriſhment to the ſyſtem, or replace its hourly waſte.

8. The

8. The ſtomach and inteſtinal canal have a conſtant vermicular motion, which carries forwards their contents, after the lacteals have drank up the chyle from them; and which is excited into action by the ſtimulus of the aliment we ſwallow, but which becomes occaſionally inverted or retrograde, as in vomiting, and in the iliac paſſion.

II. 1. The word *ſenſorium* in the following pages is deſigned to expreſs not only the medullary part of the brain, ſpinal marrow, nerves, organs of ſenſe, and of the muſcles; but alſo at the ſame time that living principle, or ſpirit of animation, which reſides throughout the body, without being cognizable to our ſenſes, except by its effects. The changes which occaſionally take place in the ſenſorium, as during the exertions of volition, or the ſenſations of pleaſure or pain, are termed *ſenſorial motions*.

2. The ſimilarity of the texture of the brain to that of the pancreas, and ſome other glands of the body, has induced the inquirers into this ſubject to believe, that a fluid, perhaps much more ſubtile than the electric aura, is ſeparated from the blood by that organ for the purpoſes of motion and ſenſation. When we recollect, that the electric fluid itſelf is actually accumulated and given out voluntarily by the torpedo and the gymnotus electricus, that an electric ſhock will frequently ſtimulate into motion a paralytic limb,

and

and laſtly that it needs no perceptible tubes to convey it, this opinion ſeems not without probability; and the ſingular figure of the brain and nervous ſyſtem ſeems well adapted to diſtribute it over every part of the body.

For the medullary ſubſtance of the brain not only occupies the cavities of the head and ſpine, but paſſes along the innumerable ramifications of the nerves to the various muſcles and organs of ſenſe. In theſe it lays aſide its coverings, and is intermixed with the ſlender fibres, which conſtitute thoſe muſcles and organs of ſenſe. Thus all theſe diſtant ramifications of the ſenſorium are united at one of their extremities, that is, in the head and ſpine; and thus theſe central parts of the ſenſorium conſtitute a communication between all the organs of ſenſe and muſcles.

3. A *nerve* is a continuation of the medullary ſubſtance of the brain from the head or ſpine towards the other parts of the body, wrapped in its proper membrane.

4. The *muſcular fibres* are moving organs intermixed with that medullary ſubſtance, which is continued along the nerves, as mentioned above. They are indued with the power of contraction, and are again elongated either by antagoniſt muſcles, by circulating fluids, or by elaſtic ligaments. So the muſcles on one ſide of the fore-arm bend the fingers by means of their tendons, and thoſe on the other ſide of the fore-arm extend them

again.

again. The arteries are diftended by the circulating blood; and in the necks of quadrupeds there is a ftrong elaftic ligament, which affifts the mufcles, which elevate the head, to keep it in its horizontal pofition, and to raife it after it has been depreffed.

5. The *immediate organs of fenfe* confift in like manner of moving fibres enveloped in the medullary fubftance above mentioned; and are erroneoufly fuppofed to be fimply an expanfion of the nervous medulla, as the retina of the eye, and the rete mucofum of the fkin, which are the immediate organs of vifion, and of touch. Hence when we fpeak of the contractions of the fibrous parts of the body, we fhall mean both the contractions of the mufcles, and thofe of the immediate organs of fenfe. Thefe *fibrous motions* are thus diftinguifhed from the *fenforial motions* above mentioned.

6. The *external organs* of fenfe are the coverings of the immediate organs of fenfe, and are mechanically adapted for the reception or tranfmiffion of peculiar bodies, or of their qualities, as the cornea and humours of the eye, the tympanum of the ear, the cuticle of the fingers and tongue.

7. The word *idea* has various meanings in the writers of metaphyfic: it is here ufed fimply for thofe notions of external things, which our organs of fenfe bring us acquainted with originally; and is defined a contraction, or motion, or configuration,

ration, of the fibres, which conſtitute the immediate organ of ſenſe; which will be explained at large in another part of the work. Synonymous with the word idea, we ſhall ſometimes uſe the words *ſenſual motion* in contradiſtinction to *muſcular motion.*

8. The word *perception* includes both the action of the organ of ſenſe in conſequence of the impact of external objects, and our attention to that action; that is, it expreſſes both the motion of the organ of ſenſe, or idea, and the pain or pleaſure that ſucceeds or accompanies it.

9. The pleaſure or pain which neceſſarily accompanies all thoſe perceptions or ideas which we attend to, either gradually ſubſides, or is ſucceeded by other fibrous motions. In the latter caſe it is termed *ſenſation,* as explained in Sect. V. 2, and VI. 2.—The reader is intreated to keep this in his mind, that through all this treatiſe the word ſenſation is uſed to expreſs pleaſure or pain only in its active ſtate, by whatever means it is introduced into the ſyſtem, without any reference to the ſtimulation of external objects.

10. The vulgar uſe of the word *memory* is too unlimited for our purpoſe: thoſe ideas which we voluntarily recall are here termed ideas of *recollection,* as when we will to repeat the alphabet backwards. And thoſe ideas which are ſuggeſted to us by preceding ideas are here termed ideas of *ſuggeſtion,* as whilſt we repeat the alphabet in the

uſual

usual order; when by habits previously acquired B is suggested by A, and C by B, without any effort of deliberation.

11. The word *association* properly signifies a society or convention of things in some respects similar to each other. We never say in common language, that the effect is associated with the cause, though they necessarily accompany or succeed each other. Thus the contractions of our muscles and organs of sense may be said to be associated together, but cannot with propriety be said to be associated with irritations, or with volition, or with sensation; because they are caused by them, as mentioned in Sect. IV. When fibrous contractions succeed other fibrous contractions, the connexion is termed *association*; when fibrous contractions succeed sensorial motions, the connexion is termed *causation*; when fibrous and sensorial motions reciprocally introduce each other in progressive trains or tribes, it is termed *catenation* of animal motions. All these connexions are said to be produced by *habit*; that is, by frequent repetition.

12. It may be proper to observe, that by the unavoidable idiom of our language the ideas of perception, of recollection, or of imagination, in the plural number signify the ideas belonging to perception, to recollection, or to imagination; whilst the idea of perception, of recollection, or of imagination, in the singular number is used for

for what is termed "a reflex idea of any of those operations of the ſenſorium."

13. By the word *ſtimulus* is not only meant the application of external bodies to our organs of ſenſe and muſcular fibres, which excites into action the ſenſorial power termed irritation; but alſo pleaſure or pain, when they excite into action the ſenſorial power termed ſenſation; and deſire or averſion, when they excite into action the power of volition; and laſtly, the fibrous contractions which precede aſſociation; as is further explained in Sect. XII. 2. 1.

## SECT. III.

### THE MOTIONS OF THE RETINA DEMONSTRATED BY EXPERIMENTS.

I. *Of animal motions and of ideas.* II. *The fibrous structure of the retina.* III. *The activity of the retina in vision.* 1. *Rays of light have no momentum.* 2. *Objects long viewed become fainter.* 3. *Spectra of black objects become luminous.* 4. *Varying spectra from gyration.* 5. *From long inspection of various colours.* IV. *Motions of the organs of sense constitute ideas.* 1. *Light from pressing the eye-ball, and sound from the pulsation of the carotid artery.* 2. *Ideas in sleep mistaken for perceptions.* 3. *Ideas of imagination produce pain and sickness like sensations.* 4. *When the organ of sense is destroyed, the ideas belonging to that sense perish.* V. *Analogy between muscular motions and sensual motions, or ideas.* 1. *They are both originally excited by irritations.* 2. *And associated together in the same manner.* 3. *Both act in nearly the same times.* 4. *Are alike strengthened or fatigued by exercise.* 5. *Are alike painful from inflammation.* 6. *Are alike benumbed by compression.* 7. *Are alike liable to paralysis.* 8. *To convulsion.* 9. *To the influence of old age.*—VI. *Objections answered.* 1. *Why we cannot invent new ideas.* 2. *If ideas resemble external objects.* 3. *Of the imagined sensation in an amputated limb.* 4. *Abstract ideas.*—VII. *What are ideas, if they are not animal motions?*

BEFORE the great variety of animal motions can be duly arranged into natural classes and orders, it is necessary to smooth the way to this yet unconquered

unconquered field of ſcience, by removing ſome obſtacles which thwart our paſſage. I. To demonſtrate that the retina and other immediate organs of ſenſe poſſeſs a power of motion, and that theſe motions conſtitute our ideas, according to the fifth and ſeventh of the preceding aſſertions, claims our firſt attention.

Animal motions are diſtinguiſhed from the communicated motions, mentioned in the firſt ſection, as they have no mechanical proportion to their cauſe; for the goad of a ſpur on the ſkin of a horſe ſhall induce him to move a load of hay. They differ from the gravitating motions there mentioned as they are exerted with equal facility in all directions, and they differ from the chemical claſs of motions, becauſe no apparent decompoſitions or new combinations are produced in the moving materials.

Hence, when we ſay animal motion is excited by irritation, we do not mean that the motion bears any proportion to the mechanical impulſe of the ſtimulus; nor that it is affected by the general gravitation of the two bodies; nor by their chemical properties; but ſolely that certain animal fibres are excited into action by ſomething external to the moving organ.

In this ſenſe the ſtimulus of the blood produces the contractions of the heart; and the ſubſtances we take into our ſtomach and bowels ſtimulate them to perform their neceſſary functions. The

rays

rays of light excite the retina into animal motion by their ſtimulus; at the ſame time that thoſe rays of light themſelves are phyſically converged to a focus by the inactive humours of the eye. The vibrations of the air ſtimulate the auditory nerve into animal action; while it is probable that the tympanum of the ear at the ſame time undergoes a mechanical vibration.

To render this circumſtance more eaſy to be comprehended, *motion may be defined to be a variation of figure*; for the whole univerſe may be conſidered as one thing poſſeſſing a certain figure; the motions of any of its parts are a variation of this figure of the whole: this definition of motion will be further explained in Section XIV. 2. 2. on the production of ideas.

Now the motions of an organ of ſenſe are a ſucceſſion of configurations of that organ; theſe configurations ſucceed each other quicker or ſlower; and whatever configuration of this organ of ſenſe, that is, whatever portion of the motion of it is, or has uſually been, attended to, conſtitutes an idea. Hence the configuration is not to be conſidered as an effect of the motion of the organ, but rather as a part or temporary termination of it; and that, whether a pauſe ſucceeds it, or a new configuration immediately takes place. Thus when a ſucceſſion of moving objects are preſented to our view, the ideas of trumpets, horns, lords and ladies, trains and canopies, are configurations,

 that

that is, parts or links of the fucceffive motions of the organ of vifion.

Thefe motions or configurations of the organs of fenfe differ from the fenforial motions to be defcribed hereafter, as they appear to be fimply contractions of the fibrous extremities of thofe organs, and in that refpect exactly refemble the motions or contractions of the larger mufcles, as appears from the following experiment. Place a circular piece of red filk about an inch in diameter on a fheet of white paper in a ftrong light, as in Plate I.—look for a minute on this area, or till the eye becomes fomewhat fatigued, and then, gently clofing your eyes, and fhading them with your hand, a circular green area of the fame apparent diameter becomes vifible in the clofed eye. This green area is the colour reverfe to the red area, which had been previoufly infpected, as explained in the experiments on ocular fpectra at the end of the work, and in Botanical Garden, P. I. additional note, No. I. Hence it appears, that a part of the retina, which had been fatigued by contraction in one direction, relieves itfelf by exerting the antagonift fibres, and producing a contraction in an oppofite direction, as is common in the exertions of our mufcles. Thus when we are tired with long action of our arms in one direction, as in holding a bridle on a journey, we occafionally throw them into an oppofite pofition to relieve the fatigued mufcles.

Mr.

Mr. Locke has defined an idea to be "whatever is present to the mind;" but this would include the exertions of volition, and the sensations of pleasure and pain, as well as those operations of our system, which acquaint us with external objects; and is therefore too unlimited for our purpose. Mr. Locke seems to have fallen into a further error, by conceiving, that the mind could form a general or abstract idea by its own operation, which was the copy of no particular perception; as of a triangle in general, that was neither acute, obtuse, nor right angled. The ingenious Dr. Berkley and Mr. Hume have demonstrated, that such general ideas have no existence in nature, not even in the mind of their celebrated inventor. We shall therefore take for granted at present, that our recollection or imagination of external objects consists of a partial repetition of the perceptions, which were excited by those external objects, at the time we became acquainted with them; and that our reflex ideas of the operations of our minds are partial repetitions of those operations.

II. The following article evinces that the organ of vision consists of a fibrous part as well as of the nervous medulla, like other white muscles; and hence, as it resembles the muscular parts of the body in its structure, we may conclude, that it must resemble them in possessing a power of being excited into animal motion.—The subsequent experiments on the optic nerve, and on the colours

remaining in the eye, are copied from a paper on ocular ſpectra publiſhed in the ſeventy-ſixth volume of the Philoſ. Tranſ. by Dr. R. Darwin of Shrewſbury; which, as I ſhall have frequent occaſion to refer to, is reprinted in this work, Sect. XL. The retina of an ox's eye was ſuſpended in a glaſs of warm water, and forcibly torn in a few places; the edges of theſe parts appeared jagged and hairy, and did not contract and become ſmooth like ſimple mucus, when it is diſtended till it breaks; which evinced that it conſiſted of fibres. This fibrous conſtruction became ſtill more diſtinct to the ſight by adding ſome cauſtic alkali to the water; as the adhering mucus was firſt eroded, and the hair-like fibres remained floating in the veſſel. Nor does the degree of tranſparency of the retina invalidate this evidence of its fibrous ſtructure, ſince Leeuwenhoek has ſhewn, that the cryſtalline humour itſelf conſiſts of fibres. Arc. Nat. V. I. 70.

Hence it appears, that as the muſcles conſiſt of larger fibres intermixed with a ſmaller quantity of nervous medulla, the organ of viſion conſiſts of a greater quantity of nervous medulla intermixed with ſmaller fibres. It is probable that the locomotive muſcles of microſcopic animals may have greater tenuity than theſe of the retina; and there is reaſon to conclude from analogy, that the other immediate organs of ſenſe, as the portio mollis of the auditory nerve, and the rete mucoſum of the ſkin,

ſkin, poſſeſs a ſimilarity of ſtructure with the retina, and a ſimilar power of being excited into animal motion.

III. The ſubſequent articles ſhew, that neither mechanical impreſſions, nor chemical combinations of light, but that the animal activity of the retina conſtitutes viſion.

1. Much has been conjectured by philoſophers about the momentum of the rays of light; to ſubject this to experiment a very light horizontal balance was conſtructed by Mr. Michel, with about an inch ſquare of thin leaf copper ſuſpended at each end of it, as deſcribed in Dr. Prieſtley's Hiſtory of Light and Colours. The focus of a very large convex mirror was thrown by Dr. Powel, in his lectures on experimental philoſophy, in my preſence, on one wing of this delicate balance, and it receded from the light; thrown on the other wing, it approached towards the light, and this repeatedly; ſo that no ſenſible impulſe could be obſerved, but what might well be aſcribed to the aſcent of heated air.

Whence it is reaſonable to conclude, that the light of the day muſt be much too weak in its dilute ſtate to make any mechanical impreſſion on ſo tenacious a ſubſtance as the retina of the eye.— Add to this, that as the retina is nearly tranſparent, it could therefore make leſs reſiſtance to the mechanical impulſe of light; which, according to the obſervations related by Mr. Melvil in the

Edinburgh Literary Eſſays, only communicates heat, and ſhould therefore only communicate momentum, where it is obſtructed, reflected, or refracted.—From whence alſo may be collected the final cauſe of this degree of tranſparency of the retina, viz. leſt by the focus of ſtronger lights, heat and pain ſhould have been produced in the retina, inſtead of that ſtimulus which excites it into animal motion.

2. On looking long on an area of ſcarlet ſilk of about an inch in diameter laid on white paper, as in Plate I. the ſcarlet colour becomes fainter, till at length it entirely vaniſhes, though the eye is kept uniformly and ſteadily upon it. Now if the change or motion of the retina was a mechanical impreſſion, or a chemical tinge of coloured light, the perception would every minute become ſtronger and ſtronger,—whereas in this experiment it becomes every inſtant weaker and weaker. The ſame circumſtance obtains in the continued application of ſound, or of ſapid bodies, or of odorous ones, or of tangible ones, to their adapted organs of ſenſe.

Thus when a circular coin, as a ſhilling, is preſſed on the palm of the hand, the ſenſe of touch is mechanically compreſſed; but it is the ſtimulus of this preſſure that excites the organ of touch into animal action, which conſtitutes the perception of hardneſs and of figure: for in ſome minutes the perception ceaſes, though the mechanical preſſure of the object remains.

3. Make

3. Make with ink on white paper a very black ſpot about half an inch in diameter, with a tail about an inch in length, ſo as to reſemble a tadpole, as in Plate II.; look ſteadfaſtly for a minute on the centre of this ſpot, and, on moving the eye a little, the figure of the tadpole will be ſeen on the white part of the paper; which figure of the tadpole will appear more luminous than the other part of the white paper; which can only be explained by ſuppoſing that part of the retina, on which the tadpole was delineated, to have become more ſenſible to light than the other parts of it, which were expoſed to the white paper; and not from any idea of mechanical impreſſion or chemical combination of light with the retina.

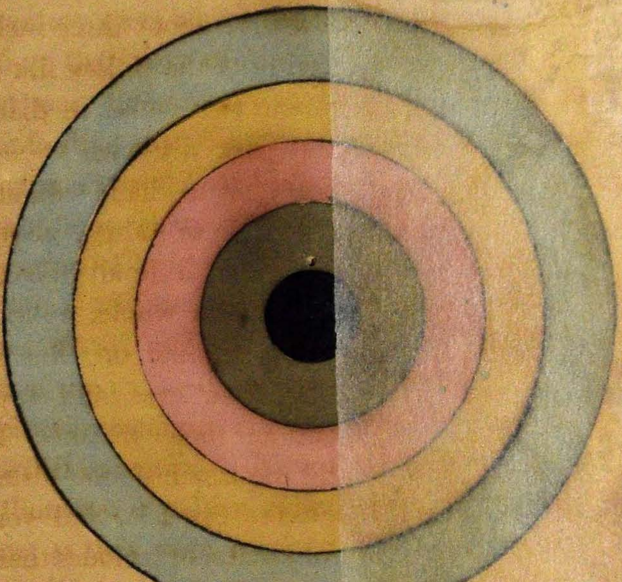
4. When any one turns round rapidly, till he becomes dizzy, and falls upon the ground, the ſpectra of the ambient objects continue to preſent themſelves in rotation, and he ſeems to behold the objects ſtill in motion. Now if theſe ſpectra were impreſſions on a paſſive organ, they either muſt continue as they were received laſt, or not continue at all.

5. Place a piece of red ſilk about an inch in diameter on a ſheet of white paper in a ſtrong light, as in Plate I.; look ſteadily upon it from the diſtance of about half a yard for a minute; then cloſing your eye-lids, cover them with your hands and handkerchief, and a green ſpectrum will be ſeen in your eyes reſembling in form the

piece of red ſilk. After ſome ſeconds of time the ſpectrum will diſappear, and in a few more ſeconds will reappear; and thus alternately three or four times, if the experiment be well made, till at length it vaniſhes entirely.

6. Place on a ſheet of white paper a circular piece of blue ſilk, about four inches in diameter, in the ſunſhine; cover the centre of this with a circular piece of yellow ſilk, about three inches in diameter; and the centre of the yellow ſilk with a circle of pink ſilk, about two inches in diameter; and the centre of the pink ſilk with a circle of green ſilk, about one inch in diameter; and the centre of this with a circle of indigo, about half an inch in diameter; make a ſmall ſpeck with ink in the very centre of the whole, as in Plate III. look ſteadily for a minute on this central ſpot, and then cloſing your eyes, and applying your hand at about an inch diſtance before them, ſo as to prevent too much or too little light from paſſing through the eye-lids, and you will ſee the moſt beautiful circles of colours that imagination can conceive; which are moſt reſembled by the colours occaſioned by pouring a drop or two of oil on a ſtill lake in a bright day. But theſe circular iriſes of colours are not only different from the colours of the ſilks above mentioned, but are at the ſame time perpetually changing as long as they exiſt.

From



From all theſe experiments it appears, that theſe ſpectra in the eye are not owing to the mechanical impulſe of light impreſſed on the retina; nor to its chemical combination with that organ; nor to the abſorption and emiſſion of light, as is ſuppoſed, perhaps erroneouſly, to take place in calcined ſhells and other phoſphoreſcent bodies, after having been expoſed to the light: for in all theſe caſes the ſpectra in the eye ſhould either remain of the ſame colour, or gradually decay, when the object is withdrawn; and neither their evaneſcence during the preſence of the object, as in the ſecond experiment, nor their change from dark to luminous, as in the third experiment, nor their rotation, as in the fourth experiment, nor the alternate preſence and evaneſcence of them, as in the fifth experiment, nor the perpetual change of colours of them, as in the laſt experiment, could exiſt.

IV. The ſubſequent articles ſhew, that theſe animal motions or configurations of our organs of ſenſe conſtitute our ideas.

1. If any one in the dark preſſes the ball of his eye, by applying his finger to the external corner of it, a luminous appearance is obſerved; and by a ſmart ſtroke on the eye great flaſhes of fire are perceived. (Newton's Optics.) So when the arteries, that are near the auditory nerve, make ſtronger pulſations than uſual, as in ſome fevers, an undulating ſound is excited in the ears. Hence it is not the preſence of the light and ſound, but the

motions

motions of the organ, that are immediately neceſſary to conſtitute the perception or idea of light and ſound.

2. During the time of ſleep, or in delirium, the ideas of imagination are miſtaken for the perceptions of external objects; whence it appears, that theſe ideas of imagination are no other than a reiteration of thoſe motions of the organs of ſenſe, which were originally excited by the ſtimulus of external objects: and in our waking hours the ſimple ideas, that we call up by recollection or by imagination, as the colour of red, or the ſmell of a roſe, are exact reſemblances of the ſame ſimple ideas from perception; and in conſequence muſt be a repetition of thoſe very motions.

3. The diſagreeable ſenſation called the tooth-edge is originally excited by the painful jarring of the teeth in biting the edge of the glaſs, or porcelain cup, in which our food was given us in our infancy, as is further explained in the Section XVI, 10, on Inſtinct.—This diſagreeable ſenſation is afterwards excited not only by a repetition of the ſound, that was then produced, but by imagination alone, as I have myſelf frequently experienced; in this caſe the idea of biting a china cup, when I imagine it very diſtinctly, or when I ſee another perſon bite a cup or glaſs, excites an actual pain in the nerves of my teeth. So that this idea and pain ſeem to be nothing more than the

reiterated

reiterated motions of thoſe nerves, that were formerly ſo diſagreeably affected.

Other ideas that are excited by imagination or recollection in many inſtances produce ſimilar effects on the conſtitution, as our perceptions had formerly produced, and are therefore undoubtedly a repetition of the ſame motions. A ſtory which the celebrated Baron Van Swieten relates of himſelf is to this purpoſe. He was preſent when the putrid carcaſe of a dead dog exploded with prodigious ſtench; and ſome years afterwards, accidentally riding along the ſame road, he was thrown into the ſame ſickneſs and vomiting by the idea of the ſtench, as he had before experienced from the perception of it.

4. Where the organ of ſenſe is totally deſtroyed, the ideas which where received by that organ ſeem to periſh along with it, as well as the power of perception. Of this a ſatisfactory inſtance has fallen under my obſervation. A gentleman about ſixty years of age had been totally deaf for near thirty years: he appeared to be a man of good underſtanding, and amuſed himſelf with reading, and by converſing either by the uſe of the pen, or by ſigns made with his fingers, to repreſent letters. I obſerved that he had ſo far forgot the pronunciation of the language, that when he attempted to ſpeak, none of his words had diſtinct articulation, though his relations could ſometimes underſtand his meaning. But, which is much to the point, he

he aſſured me, that in his dreams he always imagined that people converſed with him by ſigns or writing, and never that he heard any one ſpeak to him. From hence it appears, that with the perceptions of ſounds he has alſo loſt the ideas of them; though the organs of ſpeech ſtill retain ſomewhat of their uſual habits of articulation.

This obſervation may throw ſome light on the medical treatment of deaf people; as it may be learnt from their dreams whether the auditory nerve be paralytic, or their deafneſs be owing to ſome defect of the external organ.

It rarely happens that the immediate organ of viſion is perfectly deſtroyed. The moſt frequent cauſes of blindneſs are occaſioned by defects of the external organ, as in cataracts and obfuſcations of the cornea. But I have had the opportunity of converſing with two men, who had been ſome years blind; one of them had a complete gutta ſerena, and the other had loſt the whole ſubſtance of his eyes. They both told me that they did not remember to have ever dreamt of viſible objects, ſince the total loſs of their ſight.

V. Another method of diſcovering that our ideas are animal motions of the organs of ſenſe, is from conſidering the great analogy they bear to the motions of the larger muſcles of the body. In the following articles it will appear that they are originally excited into action by the irritation of external objects like our muſcles; are aſſociated

together

together like our muſcular motions; act in ſimilar time with them; are fatigued by continued exertion like them; and that the organs of ſenſe are ſubject to inflammation, numbneſs, palſy, convulſion, and the defects of old age, in the ſame manner as the muſcular fibres.

1. All our perceptions or ideas of external objects are univerſally allowed to have been originally excited by the ſtimulus of thoſe external objects; and it will be ſhewn in a ſucceeding ſection, that it is probable that all our muſcular motions, as well thoſe that are become voluntary as thoſe of the heart and glandular ſyſtem, were originally in like manner excited by the ſtimulus of ſomething external to the organ of motion.

2. Our ideas are alſo aſſociated together after their production preciſely in the ſame manner as our muſcular motions; which will likewiſe be fully explained in the ſucceeding ſection.

3. The time taken up in performing an idea is likewiſe much the ſame as that taken up in performing a muſcular motion. A muſician can preſs the keys of an harpſichord with his fingers in the order of a tune he has been accuſtomed to play, in as little time as he can run over thoſe notes in his mind. So we many times in an hour cover our eye-balls with our eye-lids without perceiving that we are in the dark; hence the perception or idea of light is not changed for that of darkneſs in ſo ſmall a time as the twinkling of an eye; ſo that in this

this caſe the muſcular motion of the eye-lid is performed quicker than the perception of light can be changed for that of darkneſs.—So if a fire-ſtick be whirled round in the dark, a luminous circle appears to the obſerver; if it be whirled ſomewhat ſlower, this circle becomes interrupted in one part; and then the time taken up in ſuch a revolution of the ſtick is the ſame that the obſerver uſes in changing his ideas: thus the δολιχοσκιον εγχος of Homer, the long ſhadow of the flying javelin, is elegantly deſigned to give us an idea of its velocity, and not of its length.

4. The fatigue that follows a continued attention of the mind to one object is relieved by changing the ſubject of our thoughts; as the continued movement of one limb is relieved by moving another in its ſtead. Whereas a due exerciſe of the faculties of the mind ſtrengthens and improves thoſe faculties, whether of imagination or recollection; as the exerciſe of our limbs in dancing or fencing increaſes the ſtrength and agility of the muſcles thus employed.

5. If the muſcles of any limb are inflamed, they do not move without pain; ſo when the retina is inflamed, its motions alſo are painful. Hence light is as intolerable in this kind of ophthalmia, as preſſure is to the finger in the paronychia. In this diſeaſe the patients frequently dream of having their eyes painfully dazzled; hence the idea of ſtrong light is painful as well as the reality.

lity. The firſt of theſe facts evinces that our perceptions are motions of the organs of ſenſe; and the latter, that our imaginations are alſo motions of the ſame organs.

6. The organs of ſenſe, like the moving muſcles, are liable to become benumbed, or leſs ſenſible, from compreſſion. Thus, if any perſon on a light day looks on a white wall, he may perceive the ramifications of the optic artery, at every pulſation of it, repreſented by darker branches on the white wall; which is evidently owing to its compreſſing the retina during the diaſtole of the artery. Sauvages Noſolog.

7. The organs of ſenſe and the moving muſcles are alike liable to be affected with palſy, as in the gutta ſerena, and in ſome caſes of deafneſs; and one ſide of the face has ſometimes loſt its power of ſenſation, but retained its power of motion; other parts of the body have loſt their motions, but retained their ſenſation, as in the common hemiplegia; and in other inſtances both theſe powers have periſhed together.

8. In ſome convulſive diſeaſes a delirium or inſanity ſupervenes, and the convulſions ceaſe; and converſely the convulſions ſhall ſupervene, and the delirium ceaſe. Of this I have been a witneſs many times in a day in the paroxyſms of violent epilepſies; which evinces that one kind of delirium is a convulſion of the organs of ſenſe, and

that

that our ideas are the motions of theſe organs: the ſubſequent caſes will illuſtrate this obſervation.

Miſs G——, a fair young lady, with light eyes and hair, was ſeized with moſt violent convulſions of her limbs, with outrageous hiccough, and moſt vehement efforts to vomit: after near an hour was elapſed this tragedy ceaſed, and a calm talkative delirium ſupervened for about another hour; and theſe relieved each other at intervals during the greateſt part of three or four days. After having carefully conſidered this diſeaſe, I thought the convulſions of her ideas leſs dangerous than thoſe of her muſcles; and having in vain attempted to make any opiate continue in her ſtomach, an ounce of laudanum was rubbed along the ſpine of her back, and a dram of it was uſed as an enema; by this medicine a kind of drunken delirium was continued many hours; and when it ceaſed the convulſions did not return; and the lady continued well many years, except ſome ſlighter relapſes, which were relieved in the ſame manner.

Miſs H——; an accompliſhed young lady, with light eyes and hair, was ſeized with convulſions of her limbs, with hiccough, and efforts to vomit, more violent than words can expreſs; theſe continued near an hour, and were ſucceeded with a cataleptic ſpaſm of one arm, with the hand applied to her head; and after about twenty minutes theſe ſpaſms ceaſed, and a talkative reverie ſupervened for near an other hour, from which no violence,

which

which it was proper to uſe, could awaken her. Theſe periods of convulſions, firſt of the muſcles, and then of the ideas, returned twice a day for ſeveral weeks; and were at length removed by great doſes of opium, after a great variety of other medicines and applications had been in vain experienced. This lady was ſubject to frequent relapſes, once or twice a year for many years, and was as frequently relieved by the ſame method.

Miſs W——, an elegant young lady, with black eyes and hair, had ſometimes a violent pain of her ſide, at other times a moſt painful ſtranguary, which were every day ſucceeded by delirium; which gave a temporary relief to the painful ſpaſms. After the vain exhibition of variety of medicines and applications by different phyſicians, for more than a twelvemonth, ſhe was directed to take ſome doſes of opium, which were gradually increaſed, by which a drunken delirium was kept up for a day or two, and the pains prevented from returning. A fleſh diet, with a little wine or beer, inſtead of the low regimen ſhe had previouſly uſed, in a few weeks completely eſtabliſhed her health; which, except a few relapſes, has continued for many years.

9. Laſtly, as we advance in life all the parts of the body become more rigid, are rendered leſs ſuſceptible of new habits of motion, though they retain thoſe that were before eſtabliſhed. This is ſenſibly obſerved by thoſe who apply themſelves late

late in life to muſic, fencing, or any of the mechanic arts. In the ſame manner many elderly people retain the ideas they had learned early in life, but find great difficulty in acquiring new trains of memory; inſomuch that in extreme old age we frequently ſee a forgetfulneſs of the buſineſs of yeſterday, and at the ſame time a circumſtantial remembrance of the amuſements of their youth; till at length the ideas of recollection and activity of the body gradually ceaſe together,—ſuch is the condition of humanity!—and nothing remains but the vital motions and ſenſations.

VI. 1. In oppoſition to this doctrine of the production of our ideas, it may be aſked, if ſome of our ideas, like other animal motions, are voluntary, why can we not invent new ones, that have not been received by perception? The anſwer will be better underſtood after having peruſed the ſucceeding ſection, where it will be explained, that the muſcular motions likewiſe are originally excited by the ſtimulus of bodies external to the moving organ; and that the will has only the power of repeating the motions thus excited.

2. Another objector may aſk, Can the motion of an organ of ſenſe reſemble an odour or a colour? To which I can only anſwer, that it has not been demonſtrated that any of our ideas reſemble the objects that excite them; it has generally been believed that they do not; but this ſhall be diſcuſſed at large in Sect. XIV.

3. There

3. There is another objection that at firſt view would ſeem leſs eaſy to ſurmount. After the amputation of a foot or a finger, it has frequently happened, that an injury being offered to the ſtump of the amputated limb, whether from cold air, too great preſſure, or other accidents, the patient has complained of a ſenſation of pain in the foot or finger, that was cut off. Does not this evince that all our ideas are excited in the brain, and not in the organs of ſenſe? This objection is anſwered, by obſerving that our ideas of the ſhape, place, and ſolidity of our limbs, are acquired by our organs of touch and of ſight, which are ſituated in our fingers and eyes, and not by any ſenſations in the limb itſelf.

In this caſe the pain or ſenſation, which formerly has ariſen in the foot or toes, and been propagated along the nerves to the central part of the ſenſorium, was at the ſame time accompanied with a viſible idea of the ſhape and place, and with a tangible idea of the ſolidity of the affected limb: now when theſe nerves are afterwards affected by any injury done to the remaining ſtump with a ſimilar degree or kind of pain, the ideas of the ſhape, place, or ſolidity of the loſt limb, return by aſſociation; as theſe ideas belong to the organs of ſight and touch, on which they were firſt excited.

4. If you wonder what organs of ſenſe can be excited into motion, when you call up the ideas

 of

of wisdom or benevolence, which Mr. Locke has termed abstracted ideas; I ask you by what organs of sense you first became acquainted with these ideas? And the answer will be reciprocal; for it is certain that all our ideas were originally acquired by our organs of sense; for whatever excites our perception must be external to the organ that perceives it, and we have no other inlets to knowledge but by our perceptions: as will be further explained in Section XIV. and XV. on the Productions and Classes of Ideas.

VII. If our recollection or imagination be not a repetition of animal movements, I ask, in my turn, What is it? You tell me it consists of images or pictures of things. Where is this extensive canvas hung up? or where are the numerous receptacles in which those are deposited? or to what else in the animal system have they any similitude?

That pleasing picture of objects, represented in miniature on the retina of the eye, seems to have given rise to this illusive oratory! It was forgot that this representation belongs rather to the laws of light, than to those of life; and may with equal elegance be seen in the camera obscura as in the eye; and that the picture vanishes for ever, when the object is withdrawn.

# SECT. IV.

## LAWS OF ANIMAL CAUSATION.

I. The fibres, which conſtitute the muſcles and organs of ſenſe, poſſeſs a power of contraction. The circumſtances attending the exertion of this power of CONTRACTION conſtitute the laws of animal motion, as the circumſtances attending the exertion of the power of ATTRACTION conſtitute the laws of motion of inanimate matter.

II. The ſpirit of animation is the immediate cauſe of the contraction of animal fibres, it reſides in the brain and nerves, and is liable to general or partial diminution or accumulation.

III. The ſtimulus of bodies external to the moving organ is the remote cauſe of the original contractions of animal fibres.

IV. A certain quantity of ſtimulus produces irritation, which is an exertion of the ſpirit of animation exciting the fibres into contraction.

V. A certain quantity of contraction of animal fibres, if it be perceived at all, produces pleaſure; a greater or leſs quantity of contraction, if it be perceived at all, produces pain; theſe conſtitute ſenſation.

VI. A certain quantity of ſenſation produces deſire or averſion; theſe conſtitute volition.

VII. All animal motions which have occurred at the ſame time, or in immediate ſucceſſion, become ſo connected, that when one of them is reproduced, the other has a tendency to accompany or ſucceed it. When fibrous contractions ſucceed or accompany other fibrous contractions, the connexion is termed aſſociation; when fibrous contractions ſucceed ſenſorial motions, the connexion is termed cauſation; when fibrous and ſenſorial motions reciprocally introduce each other, it is termed catenation of animal motions. All theſe connexions are ſaid to be produced by habit, that is, by frequent repetition. Theſe laws of animal cauſation will be evinced by numerous facts, which occur in our daily exertions; and will afterwards be employed to explain the more recondite phænomena of the production, growth, diſeaſes, and decay of the animal ſyſtem.

## SECT. V.

### OF THE FOUR FACULTIES OR MOTIONS OF THE SENSORIUM.

1\. *Four ſenſorial powers.* 2. *Irritation, ſenſation, volition, aſſociation defined.* 3. *Senſorial motions diſtinguiſhed from fibrous motions.*

1\. The ſpirit of animation has four different modes of action, or in other words the animal ſenſorium poſſeſſes four different faculties, which are occaſionally exerted, and cauſe all the contractions of the fibrous parts of the body. Theſe are the faculty of cauſing fibrous contractions in conſequence of the irritations excited by external bodies, in conſequence of the ſenſations of pleaſure or pain, in conſequence of volition, and in conſequence of the aſſociations of fibrous contractions with other fibrous contractions, which precede or accompany them.

Theſe four faculties of the ſenſorium during their inactive ſtate are termed irritability, ſenſibility, voluntarity, and aſſociability; in their active ſtate they are termed as above, irritation, ſenſation, volition, aſſociation.

2\. Irritation is an exertion or change of ſome extreme part of the ſenſorium reſiding in

the muſcles or organs of ſenſe, in conſequence of the appulſes of external bodies.

Sensation is an exertion or change of the central parts of the ſenſorium, or of the whole of it, *beginning* at ſome of thoſe extreme parts of it, which reſide in the muſcles or organs of ſenſe.

Volition is an exertion or change of the central parts of the ſenſorium, or of the whole of it, *terminating* in ſome of thoſe extreme parts of it, which reſide in the muſcles or organs of ſenſe.

Association is an exertion or change of ſome extreme part of the ſenſorium reſiding in the muſcles or organs of ſenſe, in conſequence of ſome antecedent or attendant fibrous contractions.

3. Theſe four faculties of the animal ſenſorium may at the time of their exertions be termed motions without impropriety of language; for we cannot paſs from a ſtate of inſenſibility or inaction to a ſtate of ſenſibility or of exertion without ſome change of the ſenſorium, and every change includes motion. We ſhall therefore ſometimes term the above deſcribed faculties *ſenſorial motions* to diſtinguiſh them from *fibrous motions*; which latter expreſſion includes the motions of the muſcles and organs of ſenſe.

The active motions of the fibres, whether thoſe of the muſcles or organs of ſenſe, are probably ſimple contractions; the fibres being again elongated by antagoniſt muſcles, by circulating fluids,

or

or ſometimes by elaſtic ligaments, as in the necks of quadrupeds. The ſenſorial motions, which conſtitute the ſenſations of pleaſure or pain, and which conſtitute volition, and which cauſe the fibrous contractions in conſequence of irritation or of aſſociation, are not here ſuppoſed to be fluctuations or refluctuations of the ſpirit of animation; nor are they ſuppoſed to be vibrations or revibrations, nor condenſations or equilibrations of it; but to be changes or motions of it peculiar to life.

# SECT. VI.

## OF THE FOUR CLASSES OF FIBROUS MOTIONS.

I. *Origin of fibrous contractions.* II. *Distribution of them into four classes, irritative motions, sensitive motions, voluntary motions, and associate motions, defined.*

I. All the fibrous contractions of animal bodies originate from the sensorium, and resolve themselves into four classes, correspondent with the four powers or motions of the sensorium above described, and from which they have their causation.

1. These fibrous contractions were originally caused by the irritations excited by objects, which are external to the moving organ. As the pulsations of the heart are owing to the irritations excited by the stimulus of the blood; and the ideas of perception are owing to the irritations excited by external bodies.

2. But as painful or pleasurable sensations frequently accompanied those irritations, by habit these fibrous contractions became causeable by the sensations, and the irritations ceased to be necessary to their production. As the secretion of

tears in grief is caused by the sensation of pain; and the ideas of imagination, as in dreams or delirium, are excited by the pleasure or pain, with which they were formerly accompanied.

3. But as the efforts of the will frequently accompanied these painful or pleasurable sensations, by habit the fibrous contractions became causable by volition; and both the irritations and sensations ceased to be necessary to their production. As the deliberate locomotions of the body, and the ideas of recollection, as when we will to repeat the alphabet backwards.

4. But as many of these fibrous contractions frequently accompanied other fibrous contractions, by habit they became causable by their associations with them; and the irritations, sensations, and volition, ceased to be necessary to their production. As the actions of the muscles of the lower limbs in fencing are associated with those of the arms; and the ideas of suggestion are associated with other ideas, which precede or accompany them; as in repeating carelessly the alphabet in its usual order after having began it.

II. We shall give the following names to these four classes of fibrous motions, and subjoin their definitions.

1. Irritative motions. That exertion or change of the sensorium, which is caused by the appulses of external bodies, either simply subsides, or is succeeded by sensation, or it produces fibrous motions;

motions; it is termed irritation, and irritative motions are thoſe contractions of the muſcular fibres, or of the organs of ſenſe, that are immediately conſequent to this exertion or change of the ſenſorium.

2. Senſitive motions. That exertion or change of the ſenſorium, which conſtitutes pleaſure or pain, either ſimply ſubſides, or is ſucceeded by volition, or it produces fibrous motions; it is termed ſenſation, and the ſenſitive motions are thoſe contractions of the muſcular fibres, or of the organs of ſenſe, that are immediately conſequent to this exertion or change of the ſenſorium.

3. Voluntary motions. That exertion or change of the ſenſorium, which conſtitutes deſire or averſion, either ſimply ſubſides, or is ſucceeded by fibrous motions; it is then termed volition, and voluntary motions are thoſe contractions of the muſcular fibres, or of the organs of ſenſe, that are immediately conſequent to this exertion or change of the ſenſorium.

4. Aſſociate motions. That exertion or change of the ſenſorium, which accompanies fibrous motions, either ſimply ſubſides, or is ſucceeded by ſenſation or volition, or it produces other fibrous motions; it is then termed aſſociation, and the aſſociate motions are thoſe contractions of the muſcular fibres, or of the organs of ſenſe, that are immediately conſequent to this exertion or change of the ſenſorium.

SECT.

# SECT. VII.

## OF IRRITATIVE MOTIONS.

*I. 1. Some mufcular motions are excited by perpetual irritations. 2. Others more frequently by fenfations. 3. Others by volition. Cafe of involuntary ftretchings in paralytic limbs. 4. Some fenfual motions are excited by perpetual irritations. 5. Others more frequently by fenfation or volition.* II. 1. *Mufcular motions excited by perpetual irritations occafionally become obedient to fenfation and to volition. 2. And the fenfual motions.* III. 1. *Other mufcular motions are affociated with the irritative ones. 2. And other ideas with irritative ones. Of letters, language, hieroglyphics. Irritative ideas exift without our attention to them.*

I. 1. MANY of our mufcular motions are excited by perpetual irritations, as thofe of the heart and arterial fyftem by the circumfluent blood. Many other of them are excited by intermitted irritations, as thofe of the ftomach and bowels by the aliment we fwallow; of the bile-ducts by the bile; of the kidneys, pancreas, and many other glands, by the peculiar fluids they feparate from the blood; and thofe of the lacteal and other abforbent veffels by the chyle, lymph, and moifture of the atmofphere. Thefe motions are

accelerated or retarded, as their correſpondent irritations are increaſed or diminiſhed, without our attention or conſciouſneſs, in the ſame manner as the various ſecretions of fruit, gum, reſin, wax, and honey, are produced in the vegetable world, and as the juices of the earth and the moiſture of the atmoſphere are abſorbed by their roots and foliage.

2. Other muſcular motions, that are moſt frequently connected with our ſenſations, as thoſe of the ſphincters of the bladder and anus, and the muſculi erectores penis, were originally excited into motion by irritation, for young children make water, and have other evacuations without attention to theſe circumſtances; "et primis etiam ab incunabulis tenduntur ſæpius puerorum penes, amore nondum expergefacto." So the nipples of young women are liable to become turgid by irritation, long before they are in a ſituation to be excited by the pleaſure of giving milk to the lips of a child.

3. The contractions of the larger muſcles of our bodies, that are moſt frequently connected with volition, were originally excited into action by internal irritations: as appears from the ſtretching or yawning of all animals after long ſleep. In the beginning of ſome fevers this irritation of the muſcles produces perpetual ſtretching and yawning; in other periods of fever an univerſal reſtleſſneſs ariſes from the ſame cauſe,

the

the patient changing the attitude of his body every minute. The repeated ſtruggles of the fœtus in the uterus muſt be owing to this internal irritation: for the fœtus can have no other inducement to move its limbs but the tædium or irkſomeneſs of a continued poſture.

The following caſe evinces, that the motions of ſtretching the limbs after a continued attitude are not always owing to the power of the will. Mr. Dean, a maſon, of Auſtry, in Leiceſterſhire, had the ſpine of the third vertebra of the back enlarged; in ſome weeks his lower extremities became feeble; and at length quite paralytic: neither the pain of bliſters, the heat of fomentations, nor the utmoſt efforts of the will could produce the leaſt motion in theſe limbs; yet twice or thrice a day for many months his feet, legs, and thighs, were affected for many minutes with forceable ſtretchings, attended with the ſenſation of fatigue; and he at length recovered the uſe of his limbs, though the ſpine continued protuberant. The ſame circumſtance is frequently ſeen in a leſs degree in the common hemiplegia; and when this happens, I have believed repeated and ſtrong ſhocks of electricity to have been of great advantage.

4. In like manner the various organs of ſenſe are originally excited into motion by various external ſtimuli adapted to this purpoſe, which motions are termed perceptions or ideas; and many of theſe motions during our waking hours are

excited by perpetual irritation, as thofe of the organs of hearing and of touch. The former by the conftant low indiftinct noifes that murmur around us, and the latter by the weight of our bodies on the parts which fupport them; and by the unceafing variations of the heat, moifture, and preffure of the atmofphere; and thefe fenfual motions, precifely as the mufcular one above mentioned, obey their correfpondent irritations without our attention or confcioufnefs.

5. Other claffes of our ideas are more frequently excited by our fenfations of pleafure or pain, and others by volition: but that thefe have all been originally excited by ftimuli from external objects, and only vary in their combinations or feparations, has been fully evinced by Mr. Locke: and are by him termed the ideas of perception in contradiftinction to thofe, which he calls the ideas of reflection.

II. 1. Thefe mufcular motions, that are excited by perpetual irritation, are neverthelefs occafionally excitable by the fenfations of pleafure or pain, or by volition; as appears by the palpitation of the heart from fear, the increafed fecretion of faliva at the fight of agreeable food, and the glow on the fkin of thofe who are afhamed. There is an inftance told in the Philofophical Tranfactions of a man, who could for a time ftop the motion of his heart when he pleafed; and Mr. D. has often told me, he could fo far increafe the peri-

ftaltic

ſtaltic motion of his bowels by voluntary efforts, as to produce an evacuation by ſtool at any time in half an hour.

2. In like manner the ſenſual motions, or ideas, that are excited by perpetual irritation, are nevertheleſs occaſionally excited by ſenſation or volition; as in the night, when we liſten under the influence of fear, or from voluntary attention, the motions excited in the organ of hearing by the whiſpering of the air in our room, the pulſation of our own arteries, or the faint beating of a diſtant watch, become objects of perception.

III. 1. Innumerable trains or tribes of other motions are aſſociated with theſe muſcular motions which are excited by irritation; as by the ſtimulus of the blood in the right chamber of the heart, the lungs are induced to expand themſelves; and the pectoral and intercoſtal muſcles, and the diaphragm, act at the ſame time by their aſſociations with them. And when the pharinx is irritated by agreeable food, the muſcles of deglutition are brought into action by aſſociation. Thus when a greater light falls on the eye, the iris is brought into action without our attention, and the ciliary proceſs, when the focus is formed before or behind the retina, by their aſſociations with the increaſed irritative motions of the organ of viſion. Many common actions of life are produced in a ſimilar manner. If a fly ſettle on my forehead, whilſt I am intent on my preſent

occupation, I diflodge it with my finger, without exciting my attention or breaking the train of my ideas.

2. In like manner the irritative ideas fuggeft to us many other trains or tribes of ideas that are affociated with them. On this kind of connexion, language, letters, hieroglyphics, and every kind of fymbol, depend. The fymbols themfelves produce irritative ideas, or fenfual motions, which we do not attend to; and other ideas, that are fucceeded by fenfation, are excited by their affociation with them. And as thefe irritative ideas make up a part of the chain of our waking thoughts, introducing other ideas that engage our attention, though themfelves are unattended to, we find it very difficult to inveftigate by what fteps many of our hourly trains of ideas gain their admittance.

It may appear paradoxical, that ideas can exift, and not be attended to; but all our perceptions are ideas excited by irritation, and fucceeded by fenfation. Now when thefe ideas excited by irritation give us neither pleafure nor pain, we ceafe to attend to them. Thus whilft I am walking through that grove before my window, I do not run againft the trees or the benches, though my thoughts are ftrenuoufly exerted on fome other object. This leads us to a diftinct knowledge of irritative ideas, for the idea of the tree or bench, which I avoid, exifts on my retina, and induces

by

by aſſociation the action of certain locomotive muſcles; though neither itſelf nor the actions of thoſe muſcles engage my attention.

Thus whilſt we are converſing on this ſubject, the tone, note, and articulation of every individual word forms its correſpondent irritative idea on the organ of hearing; but we only attend to the aſſociated ideas, that are attached by habit to theſe irritative ones, and are ſucceeded by ſenſation; thus when we read the words "PRINTING-PRESS" we do not attend to the ſhape, ſize, or exiſtence of the letters which compoſe theſe words, though each of them excites a correſpondent irritative motion of our organ of viſion, but they introduce by aſſociation our idea of the moſt uſeful of modern inventions; the capacious reſervoir of human knowledge, whoſe branching ſtreams diffuſe ſciences, arts, and morality, through all nations and all ages.

# SECT. VIII.

## OF SENSITIVE MOTIONS.

*I. 1. Senſitive muſcular motions were originally excited into action by irritation. 2. And ſenſitive ſenſual motions, ideas of imagination, dreams. II. 1. Senſitive muſcular motions are occaſionally obedient to volition. 2. And ſenſitive ſenſual motions. III. 1. Other muſcular motions are aſſociated with the ſenſitive ones. 2. And other ſenſual motions.*

I. 1. Many of the motions of our muſcles, that are excited into action by irritation, are at the ſame time accompanied with painful or pleaſureable ſenſations; and at length become by habit cauſable by the ſenſations. Thus the motions of the ſphincters of the bladder and anus were originally excited into action by irritation; for young children give no attention to theſe evacuations; but as ſoon as they become ſenſible of the inconvenience of obeying theſe irritations, they ſuffer the water or excrement to accumulate, till it diſagreeably affects them; and the action of thoſe ſphincters is then in conſequence of this diſagreeable ſenſation. So the ſecretion of ſaliva, which in young children is copiouſly produced by irritation, and drops from their mouths, is frequently

ly attended with the agreeable ſenſation produced by the maſtication of taſteful food; till at length the ſight of ſuch food to a hungry perſon excites into action theſe ſalival glands; as is ſeen in the ſlavering of hungry dogs.

The motions of thoſe muſcles, which are affected by laſcivious ideas, and thoſe which are exerted in ſmiling, weeping, ſtarting from fear, and winking at the approach of danger to the eye, and at times the actions of every large muſcle of the body become cauſable by our ſenſations. And all theſe motions are performed with ſtrength and velocity in proportion to the energy of the ſenſation that excites them, and the quantity of ſenſorial power.

2. Many of the motions of our organs of ſenſe, or ideas, that were originally excited into action by irritation, become in like manner more frequently cauſable by our ſenſations of pleaſure or pain. Theſe motions are then termed the ideas of imagination, and make up all the ſcenery and tranſactions of our dreams. Thus when any painful or pleaſurable ſenſations poſſeſs us, as of love, anger, fear; whether in our ſleep or waking hours, the ideas, that have been formerly excited by the objects of theſe ſenſations, now vividly recur before us by their connexion with theſe ſenſations themſelves. So the fair ſmiling virgin, that excited your love by her preſence, whenever that ſenſation recurs, riſes before you in imagi-

 nation;

nation; and that with all the pleasing circumstances, that had before engaged your attention. And in sleep, when you dream under the influence of fear, all the robbers, fires, and precipices, that you formerly have seen or heard of, arise before you with terrible vivacity. All these sensual motions, like the muscular ones above mentioned, are performed with strength and velocity in proportion to the energy of the sensation of pleasure or pain, which excites them, and the quantity of sensorial power.

II. 1. Many of these muscular motions above described, that are most frequently excited by our sensations, are nevertheless occasionally causable by volition; for we can smile or frown spontaneously; can make water before the quantity or acrimony of the urine produces a disagreeable sensation, and can voluntarily masticate a nauseous drug, or swallow a bitter draught, though our sensation would strongly dissuade us.

2. In like manner the sensual motions, or ideas, that are most frequently excited by our sensations, are nevertheless occasionally causable by volition, as we can spontaneously call up our last night's dream before us, tracing it industriously step by step through all its variety of scenery and transaction; or can voluntarily examine or repeat the ideas, that have been excited by our disgust or admiration.

III. 1. Innumerable trains or tribes of motions

are aſſociated with theſe ſenſitive muſcular motions above mentioned; as when a drop of water falling into the wind-pipe diſagreeably affects the air-veſſels of the lungs, they are excited into violent action; and with theſe ſenſitive motions are aſſociated the actions of the pectoral and intercoſtal muſcles, and the diaphragm; till by their united and repeated ſucceſſions the drop is returned through the larinx. The ſame occurs when any thing diſagreeably affects the noſtrils, or the ſtomach, or the uterus; variety of muſcles are excited by aſſociation into forcible action, not to be ſuppreſſed by the utmoſt efforts of the will; as in ſneezing, vomiting, and parturition.

2. In like manner with theſe ſenſitive ſenſual motions, or ideas of imagination, are aſſociated many other trains or tribes of ideas, which by ſome writers of metaphyſics have been claſſed under the terms of reſemblance, cauſation, and contiguity; and will be more fully treated of hereafter.

# SECT. IX.

## OF VOLUNTARY MOTIONS.

*I. 1. Voluntary muſcular motions are originally excited by irritations. 2. And voluntary ideas. Of reaſon. II. 1. Voluntary muſcular motions are occaſionally cauſable by ſenſations. 2. And voluntary ideas. III. 1. Voluntary muſcular motions are occaſionally obedient to irritations. 2. And voluntary ideas. IV. 1. Voluntary muſcular motions are aſſociated with other muſcular motions. 2. And voluntary ideas.*

WHEN pleaſure or pain affect the animal ſyſtem, many of its motions both muſcular and ſenſual are brought into action; as was ſhewn in the preceding ſection, and were called ſenſitive motions. The general tendency of theſe motions is to arreſt and to poſſeſs the pleaſure, or to diſlodge or avoid the pain: but if this cannot immediately be accompliſhed, deſire or averſion is produced, and the motions in conſequence of this new faculty of the ſenſorium are called voluntary.

I. 1. Thoſe muſcles of the body that are attached to bones, have in general their principal connexions with volition, as I move my pen or raiſe

raiſe my body. Theſe motions were originally excited by irritation, as was explained in the ſection on that ſubject, afterwards the ſenſations of pleaſure or pain, that accompanied the motions thus excited, induced a repetition of them; and at length many of them were voluntarily practiſed in ſucceſſion or in combination for the common purpoſes of life, as in learning to walk, or to ſpeak; and are performed with ſtrength and velocity in proportion to the energy of the volition, that excites them, and the quantity of ſenſorial power.

2. Another great claſs of voluntary motions conſiſts of the ideas of recollection. We will to repeat a certain train of ideas, as of the alphabet backwards; and if any ideas that do not belong to this intended train, intrude themſelves by other connexions, we will to reject them, and voluntarily perſiſt in the determined train. So at my approach to a houſe which I have but once viſited, and that at the diſtance of many months, I will to recollect the names of the numerous family I expect to ſee there, and I do recollect them.

On this voluntary recollection of ideas our faculty of reaſon depends, as it enables us to acquire an idea of the diſſimilitude of any two ideas. Thus if you voluntarily produce the idea of a right-angled triangle, and then of a ſquare; and after having excited theſe ideas repeatedly, you excite

excite the idea of their difference, which is that of another right-angled triangle inverted over the former; you are ſaid to reaſon upon this ſubject, or to compare your ideas.

Theſe ideas of recollection, like the muſcular motions above mentioned, were originally excited by the irritation of external bodies, and were termed ideas of perception: afterwards the pleaſure or pain, that accompanied theſe motions, induced a repetition of them in the abſence of the external body, by which they were firſt excited; and then they were termed ideas of imagination. At length they become voluntarily practiſed in ſucceſſion or in combination for the common purpoſes of life; as when we make ourſelves maſters of the hiſtory of mankind, or of the ſciences they have inveſtigated; and are then called ideas of recollection; and are performed with ſtrength and velocity in proportion to the energy of the volition that excites them, and the quantity of ſenſorial power.

II. 1. The muſcular motions above deſcribed, that are moſt frequently obedient to the will, are nevertheleſs occaſionally cauſable by painful or pleaſurable ſenſation, as in the ſtarting from fear, and the contraction of the calf of the leg in the cramp.

2. In like manner the ſenſual motions, or ideas, that are moſt frequently connected with volition, are nevertheleſs occaſionally cauſable by painful

or

or pleaſurable ſenſation. As the hiſtories of men, or the deſcription of places, which we have voluntarily taken pains to remember, ſometimes occur to us in our dreams.

III. 1. The muſcular motions that are generally ſubſervient to volition, are alſo occaſionally cauſable by irritation, as in ſtretching the limbs after ſleep, and yawning. In this manner a contraction of the arm is produced by paſſing the electric fluid from the Leyden phial along its muſcles; and that even though the limb is paralytic. The ſudden motion of the arm produces a diſagreeable ſenſation in the joint, but the muſcles ſeem to be brought into action ſimply by irritation.

2. The ideas, that are generally ſubſervient to the will, are in like manner occaſionally excited by irritation; as when we view again an object, we have before well ſtudied, and often recollected.

IV. 1. Innumerable trains or tribes of motions are aſſociated with theſe voluntary muſcular motions above mentioned; as when I will to extend my arm to a diſtant object, ſome other muſcles are brought into action, and preſerve the balance of my body. And when I wiſh to perform any ſteady exertion, as in threading a needle, or chopping with an ax, the pectoral muſcles are at the ſame time brought into action to preſerve

preferve the trunk of the body motionlefs, and we ceafe to refpire for a time.

2. In like manner the voluntary fenfual motions, or ideas of recollection, are affociated with many other trains or tribes of ideas. As when I voluntarily recollect a gothic window, that I faw fome time ago, the whole front of the cathedral occurs to me at the fame time.

SECT.

# SECT. X.

## OF ASSOCIATE MOTIONS.

*I. 1. Many muſcular motions excited by irritations in trains or tribes become aſſociated. 2. And many ideas. II. 1. Many ſenſitive muſcular motions become aſſociated. 2. And many ſenſitive ideas. III. 1. Many voluntary muſcular motions become aſſociated. 2. And then become obedient to ſenſation or irritation. 3. And many voluntary ideas become aſſociated.*

ALL the fibrous motions, whether muſcular or ſenſual, which are frequently brought into action together, either in combined tribes, or in ſucceſſive trains, become ſo connected by habit, that when one of them is reproduced the others have a tendency to ſucceed or accompany it.

I. 1. Many of our muſcular motions were originally excited in ſucceſſive trains, as the contractions of the auricles and of the ventricles of the heart; and others in combined tribes, as the various diviſions of the muſcles which compoſe the calf of the leg, which were originally irritated into ſynchronous action by the tædium or irkſomeneſs of a continued poſture. By frequent repetitions theſe motions acquire aſſociations,

which

which continue during our lives, and even after the deſtruction of the greateſt part of the ſenſorium; for the heart of a viper or frog will continue to pulſate long after it is taken from the body; and when it has entirely ceaſed to move, if any part of it is goaded with a pin, the whole heart will again renew its pulſations. This kind of connexion we ſhall term irritative aſſociation, to diſtinguiſh it from ſenſitive and voluntary aſſociations.

2. In like manner many of our ideas are originally excited in tribes; as all the objects of ſight, after we become ſo well acquainted with the laws of viſion, as to diſtinguiſh figure and diſtance as well as colour; or in trains, as while we paſs along the objects that ſurround us. The tribes thus received by irritation become aſſociated by habit, and have been termed complex ideas by the writers of metaphyſics, as this book, or that orange. The trains have received no particular name, but theſe are alike aſſociations of ideas, and frequently continue during our lives. So the taſte of a pine-apple, though we eat it blindfold, recalls the colour and ſhape of it; and we can ſcarcely think on ſolidity without figure.

II. 1. By the various efforts of our ſenſations to acquire or avoid their objects, many muſcles are daily brought into ſucceſſive or ſynchronous actions; theſe become aſſociated by habit, and are then

then excited together with great facility, and in many inſtances gain indiſſoluble connexions. So the play of puppies and kittens is a repreſentation of their mode of fighting or of taking their prey; and the motions of the muſcles neceſſary for thoſe purpoſes become aſſociated by habit, and gain a great adroitneſs of action by theſe early repetitions: ſo the motions of the abdominal muſcles, which were originally brought into concurrent action with the protruſive motion of the rectum or bladder by ſenſation, become ſo conjoined with them by habit, that they not only eaſily obey theſe ſenſations occaſioned by the ſtimulus of the excrement and urine, but are brought into violent and unreſtrainable action in the ſtrangury and teneſmus. This kind of connexion we ſhall term ſenſitive aſſociation.

2. So many of our ideas, that have been excited together or in ſucceſſion by our ſenſations, gain ſynchronous or ſucceſſive aſſociations, that are ſometimes indiſſoluble but with life. Hence the idea of an inhuman or diſhonourable action perpetually calls up before us the idea of the wretch that was guilty of it. And hence thoſe unconquerable antipathies are formed, which ſome people have to the ſight of peculiar kinds of food, of which in their infancy they have eaten to exceſs or by conſtraint.

III. 1. In learning any mechanic art, as muſic, dancing,

dancing, or the ufe of the fword, we teach many of our mufcles to act together or in fucceffion by repeated voluntary efforts; which by habit become formed into tribes or trains of affociation, and ferve all our purpofes with great facility, and in fome inftances acquire an indiffoluble union. Thefe motions are gradually formed into a habit of acting together by a multitude of repetitions, whilft they are yet feparately caufable by the will, as is evident from the long time that is taken up by children in learning to walk and to fpeak; and is experienced by every one, when he firft attempts to fkate upon the ice or to fwim: thefe we fhall term voluntary affociations.

2. All thefe mufcular movements, when they are thus affociated into tribes or trains, become afterwards not only obedient to volition, but to the fenfations and irritations; and the fame movement compofes a part of many different tribes or trains of motion. Thus a fingle mufcle, when it acts in confort with its neighbours on one fide, affifts to move the limb in one direction; and in another, when it acts with thofe in its neighbourhood on the other fide; and in other directions, when it acts feparately or jointly with thofe that lie immediately under or above it; and all thefe with equal facility after their affociations have been well eftablifhed.

The facility, with which each mufcle changes from

from one affociated tribe to another, and that either backwards or forwards, is well obfervable in the mufcles of the arm in moving the windlafs of an air-pump; and the flownefs of thofe mufcular movements, that have not been affociated by habit, may be experienced by any one, who fhall attempt to faw the air quick perpendicularly with one hand, and horizontally with the other at the fame time.

3. In learning every kind of fcience we voluntarily affociate many tribes and trains of ideas, which afterwards are ready for all the purpofes either of volition, fenfation, or irritation; and in fome inftances acquire indiffoluble habits of acting together, fo as to affect our reafoning, and influence our actions. Hence the neceffity of a good education.

Thefe affociate ideas are gradually formed into habits of acting together by frequent repetition, while they are yet feparately obedient to the will; as is evident from the difficulty we experience in gaining fo exact an idea of the front of St. Paul's church, as to be able to delineate it with accuracy, or in recollecting a poem of a few pages.

And thefe ideas, thus affociated into tribes, not only make up the parts of the trains of volition, fenfation, and irritation; but the fame idea compofes a part of many different tribes and trains of ideas. So the fimple idea of whitenefs compofes a part of the complex idea of fnow, milk, ivory;

 and

and the complex idea of the letter A compoſes a part of the ſeveral aſſociated trains of ideas that make up the varietyof words, into which this letter enters.

The numerous trains of theſe aſſociated ideas are divided by Mr. Hume into three claſſes, which he has termed contiguity, cauſation, and reſemblance. Nor ſhould we wonder to find them thus connected together, ſince it is the buſineſs of our lives to diſpoſe them into theſe three claſſes; and we become valuable to ourſelves and our friends, as we ſucceed in it. Thoſe who have combined an extenſive claſs of ideas by the contiguity of time or place, are men learned in the hiſtory of mankind, and of the ſciences they have cultivated. Thoſe who have connected a great claſs of ideas of reſemblances, poſſeſs the ſource of the ornaments of poetry and oratory, and of all rational analogy. While thoſe who have connected great claſſes of ideas of cauſation, are furniſhed with the powers of producing effects. Theſe are the men of active wiſdom, who lead armies to victory, and kingdoms to proſperity; or diſcover and improve the ſciences, which meliorate and adorn the condition of humanity.

## SECT. XI.

### ADDITIONAL OBSERVATIONS ON THE SENSORIAL POWERS.

I. *Stimulation is of various kinds, adapted to the organs of ſenſe, to the muſcles, to hollow membranes, and glands. Some objects irritate our ſenſes by repeated impulſes.* II. 1. *Senſation and volition frequently affect the whole ſenſorium.* 2. *Emotions, paſſions, appetites.* 3. *Origin of deſire and averſion. Criterion of voluntary actions, difference of brutes and men.* 4. *Senſibility and voluntarity.* III. *Aſſociations formed before nativity, irritative motions miſtaken for aſſociated ones.*

### *Irritation.*

I. The various organs of ſenſe require various kinds of ſtimulation to excite them into action; the particles of light penetrate the cornea and humours of the eye, and then irritate the naked retina; ſapid particles, diſſolved or diffuſed in water or ſaliva, and odorous ones, mixed or combined with the air, irritate the extremities of the nerves of taſte and ſmell; which either penetrate, or are expanded on the membranes of the tongue and noſtrils; the auditory nerves are ſtimulated by the vibrations of the atmoſphere communicated by means of the tympanum and of the fluid,

 whether

whethor of air or of water, behind it; and the nerves of touch by the hardneſs of ſurrounding bodies, though the cuticle is interpoſed between theſe bodies and the medulla of the nerve.

As the nerves of the ſenſes have each their appropriated objects, which ſtimulate them into activity; ſo the muſcular fibres, which are the terminations of other ſets of nerves, have their peculiar objects, which excite them into action; the longitudinal muſcles are ſtimulated into contraction by extenſion, whence the ſtretching or pandiculation after a long continued poſture, during which they have been kept in a ſtate of extenſion; and the hollow muſcles are excited into action by diſtention, as thoſe of the rectum and bladder are induced to protrude their contents from their ſenſe of the diſtention rather than of the acrimony of thoſe contents.

There are other objects adapted to ſtimulate the nerves, which terminate in variety of membranes, and thoſe eſpecially which form the terminations of canals; thus the preparations of mercury particularly affect the ſalivary glands, ipecacuanha the ſtomach, aloe the ſphincter of the anus, cantharides that of the bladder, and laſtly every gland of the body appears to be indued with a kind of taſte, by which it ſelects or forms each its peculiar fluid from the blood; and by which it is irritated into activity.

Many

Many of thefe external properties of bodies, which ftimulate our organs of fenfe, do not feem to effect this by a fingle impulfe, but by repeated impulfes; as the nerve of the ear is probably not excitable by a fingle vibration of air, nor the optic nerve by a fingle particle of light; which circumftance produces fome analogy between thofe two fenfes, at the fame time the folidity of bodies is perceived by a fingle application of a folid body to the nerves of touch, and that even through the cuticle; and we are probably poffeffed of a peculiar fenfe to diftinguifh the nice degrees of heat and cold.

The fenfes of touch and of hearing acquaint us with the mechanical impact and vibration of bodies, thofe of fmell and tafte feem to acquaint us with fome of their chemical properties, while the fenfes of vifion and of heat acquaint us with the exiftence of their peculiar fluids.

*Senfation and Volition.*

II. Many motions are produced by pleafure or pain, and that even in contradiction to the power of volition, as in laughing, or in the ftrangury; but as no name has been given to pleafure or pain, at the time it is exerted fo as to caufe fibrous motions, we have ufed the term fenfation for this

purpofe; and mean it to bear the fame analogy to pleafure and pain, that the word volition does to defire and averfion.

1. It was mentioned in the fifth Section, that, what we have termed fenfation is a motion of the central parts, or of the whole fenforium, *beginning* at fome of the extremities of it. This appears firft, becaufe our pains and pleafures are always caufed by our ideas or mufcular motions, which are the motions of the extremities of the fenforium. And, fecondly, becaufe the fenfation of pleafure or pain frequently continues fome time after the ideas or mufcular motions which excited it have ceafed: for we often feel a glow of pleafure from an agreeable reverie, for many minutes after the ideas, that were the fubject of it, have efcaped our memory; and frequently experience a dejection of fpirits without being able to affign the caufe of it but by much recollection.

When the fenforial faculty of defire or averfion is excited fo as to caufe fibrous motions, it is termed volition; which is faid in Sect. V. to be a motion of the central parts, or of the whole fenforium, *terminating* in fome of the extremities of it. This appears, firft, becaufe our defires and averfions always terminate in recollecting and comparing our ideas, or in exerting our mufcles; which are the motions of the extremities of the fenforium. And, fecondly, becaufe defire or

averſion begins, and frequently continues for a time in the central parts of the ſenſorium, before it is peculiarly exerted at the extremities of it; for we ſometimes feel deſire or averſion without immediately knowing their objects, and in conſequence without immediately exerting any of our muſcular or ſenſual motions to attain them: as in the beginning of the paſſion of love, and perhaps of hunger, or in the ennui of indolent people.

Though ſenſation and volition begin or terminate at the extremities or central parts of the ſenſorium, yet the whole of it is frequently influenced by the exertion of theſe faculties, as appears from their effects on the external habit: for the whole ſkin is reddened by ſhame, and an univerſal trembling is produced by fear: and every muſcle of the body is agitated in angry people by the deſire of revenge.

There is another very curious circumſtance, which ſhews that ſenſation and volition are movements of the ſenſorium in contrary directions; that is, that volition begins at the central parts of it, and proceeds to the extremities; and that ſenſation begins at the extremities, and proceeds to the central parts: I mean that theſe two ſenſorial faculties cannot be ſtrongly exerted at the ſame time; for when we exert our volition ſtrongly, we do not attend to pleaſure or pain; and converſely, when we are ſtrongly affected

with the ſenſation of pleaſure or pain, we uſe no volition. As will be further explained in Section XVIII. on ſleep, and Section XXXIV. on volition.

2. All our emotions and paſſions ſeem to ariſe out of the exertions of theſe two faculties of the animal ſenſorium. Pride, hope, joy, are the names of particular pleaſures: ſhame, deſpair, ſorrow, are the names of peculiar pains: and love, ambition, avarice, of particular deſires: hatred, diſguſt, fear, anxiety, of particular averſions. Whilſt the paſſion of anger includes the pain from a recent injury, and the averſion to the adverſary that occaſioned it. And compaſſion is the pain we experience at the ſight of miſery, and the deſire of relieving it.

There is another tribe of deſires, which are commonly termed appetites, and are the immediate conſequences of the abſence of ſome irritative motions. Thoſe, which ariſe from defect of internal irritations, have proper names conferred upon them, as hunger, thirſt, luſt, and the deſire of air, when our reſpiration is impaired by noxious vapours; and of warmth, when we are expoſed to too great a degree of cold. But thoſe, whoſe ſtimuli are external to the body, are named from the objects, which are by nature conſtituted to excite them; theſe deſires originate from our paſt experience of the pleaſurable ſenſations they occaſion,

occaſion, as the ſmell of a hyacinth, or the taſte of a pine-apple.

Whence it appears, that our pleaſures and pains are at leaſt as various and as numerous as our irritations; and that our deſires and averſions muſt be as numerous as our pleaſures and pains. And that as ſenſation is here uſed as a general term for our numerous pleaſures and pains, when they produce the contractions of our fibres; ſo volition is the general name for our deſires and averſions, when they produce fibrous contractions. Thus when a motion of the central parts, or of the whole ſenſorium, terminates in the exertion of our muſcles, it is generally called voluntary action; when it terminates in the exertion of our ideas, it is termed recollection, reaſoning, determining.

3. As the ſenſations of pleaſure and pain are originally introduced by the irritations of external objects: ſo our deſires and averſions are originally introduced by thoſe ſenſations; for when the objects of our pleaſures or pains are at a diſtance, and we cannot inſtantaneouſly poſſeſs the one, or avoid the other, then deſire or averſion is produced, and a voluntary exertion of our ideas or muſcles ſucceeds.

The pain of hunger excites you to look out for food, the tree, that ſhades you, preſents its odoriferous fruit before your eyes, you approach, pluck, and eat.

The various movements of walking to the tree, gathering the fruit, and maſticating it, are aſſociated motions introduced by their connexion with ſenſation; but if from the uncommon height of the tree, the fruit be inacceſſible, and you are prevented from quickly poſſeſſing the intended pleaſure, deſire is produced. The conſequence of this deſire is, firſt, a deliberation about the means to gain the object of pleaſure in proceſs of time, as it cannot be procured immediately; and, ſecondly, the muſcular action neceſſary for this purpoſe.

You voluntarily call up all your ideas of cauſation, that are related to the effect you deſire, and voluntarily examine and compare them, and at length determine whether to aſcend the tree, or to gather ſtones from the neighbouring brook, is eaſier to practiſe, or more promiſing of ſucceſs; and, finally, you gather the ſtones, and repeatedly fling them to diſlodge the fruit.

Hence then we gain a criterion to diſtinguiſh voluntary acts or thoughts from thoſe cauſed by ſenſation. As the former are always employed about the *means* to acquire pleaſurable objects, or the *means* to avoid painful ones; while the latter are employed in the poſſeſſion of thoſe, which are already in our power.

Hence the activity of this power of volition produces the great difference between the human and the brute creation. The ideas and the ac-

tions of brutes are almoſt perpetually employed about their preſent pleaſures, or their preſent pains; and, except in the few inſtances which are mentioned in Section XVI. on inſtinct, they ſeldom buſy themſelves about the means of procuring future bliſs; or of avoiding future miſery; ſo that the acquiring of languages, the making of tools, and labouring for money, which are all only the means to procure pleaſures; and the praying to the Deity, as another means to procure happineſs, are characteriſtic of human nature.

4. As there are many diſeaſes produced by the quantity of the ſenſation of pain or pleaſure being too great or too little; ſo are there diſeaſes produced by the ſuſceptibility of the conſtitution to motions cauſable by theſe ſenſations being too dull or too vivid. This ſuſceptibility of the ſyſtem to ſenſitive motions is termed ſenſibility, to diſtinguiſh it from ſenſation, which is the actual exiſtence or exertion of pain or pleaſure.

Other claſſes of diſeaſes are owing to the exceſſive promptitude, or ſluggiſhneſs of the conſtitution to voluntary exertions, as well as to the quantity of deſire or of averſion. This ſuſceptibility of the ſyſtem to voluntary motions is termed voluntarity, to diſtinguiſh it from volition, which is the exertion of deſire or averſion; theſe diſeaſes will be treated of at length in the progreſs of the work.

*Aſſociation.*

*Association.*

III. 1. It is not eafy to affign a caufe, why thofe animal movements, that have once occurred in fucceffion, or in combination, fhould afterwards have a tendency to fucceed or accompany each other. It is a property of animation, and diftinguifhes this order of being from the other productions of nature.

When a child firft wrote the word man, it was diftinguifhed in his mind into three letters, and thofe letters into many parts of letters; but by repeated ufe the word man becomes to his hand in writing it, as to his organs of fpeech in pronouncing it, but one movement without any deliberation, or fenfation, or irritation, interpofed between the parts of it. And as many feparate motions of our mufcles thus become united, and form, as it were, one motion; fo each feparate motion before fuch union may be conceived to confift of many parts or fpaces moved through; and perhaps even the individual fibres of our mufcles have thus gradually been brought to act in concert, which habits began to be acquired as early as the very formation of the moving organs, long before the nativity of the animal; as explained in the Section XVI. 2. on inftinct.

2. There are many motions of the body, belonging to the irritative clafs, which might by a hafty

haſty obſerver be miſtaken for aſſociated ones; as the periſtaltic motion of the ſtomach and inteſtines, and the contractions of the heart and arteries, might be ſuppoſed to be aſſociated with the irritative motions of their nerves of ſenſe, rather than to be excited by the irritation of their muſcular fibres by the diſtention, acrimony, or momentum of the blood. So the diſtention or elongation of muſcles by objects external to them irritates them into contraction, though the cuticle or other parts may intervene between the ſtimulating body and the contracting muſcle. Thus a horſe voids his excrement when its weight or bulk irritates the rectum or ſphincter ani. Theſe muſcles act from the irritation of diſtention, when he excludes his excrement, but the muſcles of the abdomen and diaphragm are brought into motion by aſſociation with thoſe of the ſphincter and rectum.

SECT.

## SECT. XII.

### OF STIMULUS, SENSORIAL EXERTION, AND FIBROUS CONTRACTION.

I. Of fibrous contraction. 1. *Two particles of a fibre cannot approach without the intervention of ſomething, as in magnetiſm, electricity, elaſticity. Spirit of life is not electric ether. Galvani's experiments.* 2. *Contraction of a fibre.* 3. *Relaxation ſucceeds.* 4. *Succeſſive contractions, with intervals. Quick pulſe from debility, from paucity of blood. Weak contractions performed in leſs time, and with ſhorter intervals.* 5. *Laſt ſituation of the fibres continues after contraction.* 6. *Contraction greater than uſual induces pleaſure or pain.* 7 *Mobility of the fibres uniform. Quantity of ſenſorial power fluctuates. Conſtitutes excitability.* II. Of ſenſorial exertion. 1. *Animal motion includes ſtimulus, ſenſorial power, and contractile fibres. The ſenſorial faculties act ſeparately or conjointly. Stimulus of four kinds. Strength and weakneſs defined. Senſorial power perpetually exhauſted and renewed. Weakneſs from defect of ſtimulus. From defect of ſenſorial power, the direct and indirect debility of Dr. Brown. Why we become warm in Buxton bath after a time, and ſee well after a time in a darkiſh room. Fibres may act violently, or with their whole force, and yet feebly. Great exertion in inflammation explained. Great muſcular force of ſome inſane people.* 2. *Occaſional accumulation of ſenſorial power in muſcles ſubject to conſtant ſtimulus. In animals ſleeping in winter. In eggs, ſeeds, ſcirrhous tumours, tendons, bones.* 3. *Great exertion introduces pleaſure or pain. Inflammation. Libration of the ſyſtem*

*ſyſtem between torpor and activity. Fever-fits.* 4. *Deſire and averſion introduced. Exceſs of volition cures fevers.* III. Of repeated ſtimulus. 1. *A ſtimulus repeated too frequently loſes effect. As opium, wine, grief. Hence old age. Opium and aloes in ſmall doſes.* 2. *A ſtimulus not repeated too frequently does not loſe effect. Perpetual movement of the vital organs.* 3. *A ſtimulus repeated at uniform times produces greater effect. Irritation combined with aſſociation.* 4. *A ſtimulus repeated frequently and uniformly may be withdrawn, and the action of the organ will continue. Hence the bark cures agues, and ſtrengthens weak conſtitutions.* 5. *Defect of ſtimulus repeated at certain intervals cauſes fever-fits.* 6. *Stimulus long applied ceaſes to act a ſecond time.* 7. *If a ſtimulus excites ſenſation in an organ not uſually excited into ſenſation, inflammation is produced.* IV. Of ſtimulus greater than natural. 1. *A ſtimulus greater than natural diminiſhes the quantity of ſenſorial power in general.* 2. *In particular organs.* 3. *Induces the organ into ſpaſmodic actions.* 4. *Induces the antagoniſt fibres into action.* 5. *Induces the organ into convulſive or fixed ſpaſms.* 6. *Produces paralyſis of the organ.* V. Of ſtimulus leſs than natural. 1. *Stimulus leſs than natural occaſions accumulation of ſenſorial power in general.* 2. *In particular organs, fluſhing of the face in a froſty morning. In fibres ſubject to perpetual ſtimulus only. Quantity of ſenſorial power inverſely as the ſtimulus.* 3. *Induces pain. As of cold, hunger, head ach.* 4. *Induces more feeble and frequent contraction. As in low fevers. Which are frequently owing to deficiency of ſenſorial power rather than to deficiency of ſtimulus.* 5. *Inverts ſucceſſive trains of motion. Inverts ideas.* 6. *Induces paralyſis and death.* VI. Cure of increaſed exertion. 1. *Natural cure of exhauſtion of ſenſorial power.* 2. *Decreaſe the irritations. Veneſection. Cold. Abſtinence.* 3. *Prevent the previous*

*cold*

*cold fit. Opium. Bark. Warmth. Anger. Surprise.* 4. *Excite some other part of the system. Opium and warm bath relieve pains both from defect and from excess of stimulus.* 5. *First increase the stimulus above, and then decrease it beneath the natural quantity.* VII. Cure of decreased exertion. 1. *Natural cure by accumulation of sensorial power. Ague-fits. Syncope.* 2. *Increase the stimulation, by wine, opium, given so as not to intoxicate. Cheerful ideas.* 3. *Change the kinds of stimulus.* 4. *Stimulate the associated organs. Blisters of use in heart-burn, and cold extremities.* 5 *Decrease the stimulation for a time, cold bath.* 6. *Decrease the stimulation below natural, and then increase it above natural. Bark after emetics. Opium after venesection. Practice of Sydenham in chlorosis.* 7. *Prevent unnecessary expenditure of sensorial power. Decumbent posture, silence, darkness. Pulse quickened by rising out of bed.* 8. *To the greatest degree of quiescence apply the least stimulus. Otherwise paralysis or inflammation of the organ ensues. Gin, wine, blisters, destroy by too great stimulation in fevers with debility. Intoxication in the slightest degree succeeded by debility. Golden rule for determining the best degree of stimulus in low fevers. Another golden rule for determining the quantity of spirit which those, who are debilitated by drinking it, may safely omit.* VIII. *Conclusion. Some stimuli increase the production of sensorial power.*

## I. *Of fibrous contraction.*

1. If two particles of iron lie near each other without motion, and afterwards approach each other; it is reasonable to conclude that something besides the iron particles is the cause of their approximation; this invisible something is termed magnetism.

magnetiſm. In the ſame manner, if the particles, which compoſe an animal muſcle, do not touch each other in the relaxed ſtate of the muſcle, and are brought into contact during the contraction of the muſcle; it is reaſonable to conclude, that ſome other agent is the cauſe of this new approximation. For *nothing can act, where it does not exiſt; for to act includes to exiſt*; and therefore the particles of the muſcular fibre (which in its ſtate of relaxation are ſuppoſed not to touch) cannot affect each other without the influence of ſome intermediate agent; this agent is here termed the ſpirit of animation, or ſenſorial power, but may with equal propriety be termed the power, which cauſes contraction; or may be called by any other name, which the reader may chooſe to affix to it.

The contraction of a muſcular fibre may be compared to the following electric experiment, which is here mentioned not as a philoſophical analogy, but as an illuſtration or ſimile to facilitate the conception of a difficult ſubject. Let twenty very ſmall Leyden phials properly coated be hung in a row by fine ſilk threads at a ſmall diſtance from each other; let the internal charge of one phial be poſitive, and of the other negative alternately, if a communication be made from the internal ſurface of the firſt to the external ſurface of the laſt in the row, they will all of them inſtantly approach each other, and thus ſhorten a

line that might connect them like a mufcular fibre. See Botanic Garden, P. I. Canto I. l. 202. note on Gymnotus.

The attractions of electricity or of magnetifm do not apply philofophically to the illuftration of the contraction of animal fibres, fince the force of thofe attractions increafes in fome proportion inverfely as the diftance, but in mufcular motion there appears no difference in velocity or ftrength during the beginning or end of the contraction, but what may be clearly afcribed to the varying mechanic advantage in the approximation of one bone to another. Nor can mufcular motion be affimilated with greater plaufibility to the attraction of cohefion or elafticity; for in bending a fteel fpring, as a fmall fword, a lefs force is required to bend it the firft inch than the fecond; and the fecond than the third; the particles of fteel on the convex fide of the bent fpring endeavouring to reftore themfelves more powerfully the further they are drawn from each other. See Botanic Garden, P. I. addit. Note XVIII.

I am aware that this may be explained another way, by fuppofing the elafticity of the fpring to depend more on the conpreffion of the particles on the concave fide than on the extenfion of them on the convex fide; and by fuppofing the elafticity of the elaftic gum to depend more on the refiftance to the lateral compreffion of its particles than to the longitudinal extenfion of them. Nevertheless

vertheleſs in muſcular contraction, as above obſerved, there appears no difference in the velocity or force of it at its commencement or at its termination; from whence we muſt conclude that animal contraction is governed by laws of its own, and not by thoſe of mechanics, chemiſtry, magnetiſm, or electricity.

On theſe accounts I do not think the experiments concluſive, which were lately publiſhed by Galvani, Volta, and others, to ſhew a ſimilitude between the ſpirit of animation, which contracts the muſcular fibres, and the electric fluid. Since the electric fluid may act only as a more potent ſtimulus exciting the muſcular fibres into action, and not by ſupplying them with a new quantity of the ſpirit of life. Thus in a recent hemiplegia I have frequently obſerved, when the patient yawned and ſtretched himſelf, that the paralytic limbs moved alſo, though they were totally diſobedient to the will. And when he was electrified by paſſing ſhocks from the affected hand to the affected foot, a motion of the paralytic limbs was alſo produced. Now as in the act of yawning the muſcles of the paralytic limbs were excited into action by the ſtimulus of the irkſomeneſs of a continued poſture, and not by any additional quantity of the ſpirit of life; ſo we may conclude, that the paſſage of the electric fluid, which produced a ſimilar effect, acted only as a ſtimulus, and not by ſupplying any addition of ſenſorial power.

If neverthelefs this theory fhould ever become eftablifhed, a ftimulus muft be called an eductor of vital ether; which ftimulus may confift of fenfation or volition, as in the electric eel, as well as in the appulfes of external bodies; and by drawing off the charges of vital fluid may occafion the contraction or motions of the mufcular fibres, and organs of fenfe.

2. The immediate effect of the action of the fpirit of animation or fenforial power on the fibrous parts of the body, whether it acts in the mode of irritation, fenfation, volition, or affociation, is a contraction of the animal fibre, according to the fecond law of animal caufation. Sect. IV. Thus the ftimulus of the blood induces the contraction of the heart; the agreeable tafte of a ftrawberry produces the contraction of the mufcles of deglutition; the effort of the will contracts the mufcles, which move the limbs in walking; and by affociation other mufcles of the trunk are brought into contraction to preferve the balance of the body. The fibrous extremities of the organs of fenfe have been fhewn, by the ocular fpectra in Sect. III. to fuffer fimilar contraction by each of the above modes of excitation; and by their configurations to conftitute our ideas.

3. After animal fibres have for fome time been excited into contraction, a relaxation fucceeds, even though the exciting caufe continues to act. In refpect to the irritative motions this is exemplified

plified in the periſtaltic contractions of the bowels; which ceaſe and are renewed alternately, though the ſtimulus of the aliment continues to be uniformly applied; in the ſenſitive motions, as in ſtrangury, teneſmus, and parturition, the alternate contractions and relaxations of the muſcles exiſt, though the ſtimulus is perpetual. In our voluntary exertions it is experienced, as no one can hang long by the hands, however vehemently he wills ſo to do; and in the aſſociate motions the conſtant change of our attitudes evinces the neceſſity of relaxation to thoſe muſcles, which have been long in action.

This relaxation of a muſcle after its contraction, even though the ſtimulus continues to be applied, appears to ariſe from the expenditure or diminution of the ſpirit of animation previouſly reſident in the muſcle, according to the ſecond law of animal cauſation in Sect. IV. In thoſe conſtitutions, which are termed weak, the ſpirit of animation becomes ſooner exhauſted, and tremulous motions are produced, as in the hands of infirm people, when they lift a cup to their mouths. This quicker exhauſtion of the ſpirit of animation is probably owing to a leſs quantity of it reſiding in the acting fibres, which therefore more frequently require a ſupply from the nerves, which belong to them.

4. If the ſenſorial power continues to act, whether it acts in the mode of irritation, ſenſa-

tion, volition, or aſſociation, a new contraction of the animal fibre ſucceeds after a certain interval; which interval is of ſhorter continuance in weak people than in ſtrong ones. This is exemplified in the ſhaking of the hands of weak people, when they attempt to write. In a manuſcript epiſtle of one of my correſpondents, which is written in a ſmall hand, I obſerved from four to ſix zigzags in the perpendicular ſtroke of every letter, which ſhews that both the contractions of the fingers, and intervals between them, muſt have been performed in very ſhort periods of time.

The times of contraction of the muſcles of enfeebled people being leſs, and the intervals between thoſe contractions being leſs alſo, accounts for the quick pulſe in fevers with debility, and in dying animals. The ſhortneſs of the intervals between one contraction and another in weak conſtitutions, is probably owing to the general deficiency of the quantity of the ſpirit of animation, and that therefore there is a leſs quantity of it to be received at each interval of the activity of the fibres. Hence in repeated motions, as of the fingers in performing on the harpſichord, it would at firſt ſight appear, that ſwiftneſs and ſtrength were incompatible; nevertheleſs the ſingle contraction of a muſcle is performed with greater velocity as well as with greater force by vigorous conſtitutions, as in throwing a javelin.

There is however another circumſtance, which may

may often contribute to cauſe the quickneſs of the pulſe in nervous fevers, as in animals bleeding to death in the ſlaughter-houſe; which is the deficient quantity of blood; whence the heart is but half diſtended, and in conſequence ſooner contracts. See Sect. XXXII. 2. 1.

For we muſt not confound frequency of repetition with quickneſs of motion, or the number of pulſations with the velocity, with which the fibres, which conſtitute the coats of the arteries, contract themſelves. For where the frequency of the pulſations is but ſeventy-five in a minute, as in health; the contracting fibres, which conſtitute the ſides of the arteries, may move through a greater ſpace in a given time, than where the frequency of pulſation is one hundred and fifty in a minute, as in ſome fevers with great debility. For if in thoſe fevers the arteries do not expand themſelves in their diaſtole to more than half the uſual diameter of their diaſtole in health, the fibres which conſtitute their coats, will move through a leſs ſpace in a minute than in health, though they make two pulſations for one.

Suppoſe the diameter of the artery during its ſyſtole to be one line, and that the diameter of the ſame artery during its diaſtole is in health four lines, and in a fever with great debility only two lines. It follows that the arterial fibres contract in health from a circle of twelve lines in circumference to a circle of three lines in cir-

cumference, that is they move through a ſpace of nine lines in length. While the arterial fibres in the fever with debility would twice contract from a circle of ſix lines to a circle of three lines; that is while they move through a ſpace equal to ſix lines. Hence though the frequency of pulſation in fever be greater as two to one, yet the velocity of contraction in health is greater as nine to ſix, or as three to two.

On the contrary in inflammatory diſeaſes with ſtrength, as in the pleuriſy, the velocity of the contracting ſides of the arteries is much greater than in health: for if we ſuppoſe the number of pulſations in a pleuriſy to be half as much more than in health, that is as one hundred and twenty to eighty, (which is about what generally happens in inflammatory diſeaſes) and if the diameter of the artery in diaſtole be one third greater than in health, which I believe is near the truth, the reſult will be, that the velocity of the contractile ſides of the arteries will be in a pleuriſy as two and a half to one, compared to the velocity of their contraction in a ſtate of health; for if the circumference of the ſyſtole of the artery be three lines, and the diaſtole in health be twelve lines in circumference, and in a pleuriſy eighteen lines; and ſecondly, if the artery pulſates thrice in the diſeaſed ſtate for twice in the healthy one, it follows, that the velocity of contraction in the diſeaſed ſtate to that in the healthy ſtate will be

forty-

forty-five to eighteen, or as two and a half to one.

From hence it would appear, that if we had a criterion to determine the velocity of the arterial contractions, it would at the ſame time give us their ſtrength, and thus be of more ſervice in diſtinguiſhing diſeaſes, than the knowledge of their frequency. As ſuch a criterion cannot be had, the frequency of pulſation, the age of the patient being allowed for, will in ſome meaſure aſſiſt us to diſtinguiſh arterial ſtrength from arterial debility, ſince in inflammatory diſeaſes with ſtrength the frequency ſeldom exceeds one hundred and eighteen or one hundred and twenty pulſations in a minute; unleſs under ſome peculiar circumſtance, as the great additional ſtimuli of wine or of external heat.

5. After a muſcle or organ of ſenſe has been excited into contraction, and the ſenſorial power ceaſes to act, the laſt ſituation or configuration of it continues; unleſs it be diſturbed by the action of ſome antagoniſt fibres, or other extraneous power. Thus in weak or languid people, wherever they throw their limbs on their bed or ſofa, there they lie, till another exertion changes their attitude; hence one kind of ocular ſpectra ſeems to be produced after looking at bright objects; thus when a fire-ſtick is whirled round in the night, there appears in the eye a complete circle of fire; the action or configuration of one part

of

of the retina not ceafing before the return of the whirling fire.

Thus if any one looks at the fetting fun for a fhort time, and then covers his clofed eyes with his hand, he will for many feconds of time perceive the image of the fun on his retina. A fimilar image of all other bodies would remain fome time in the eye, but is effaced by the eternal change of the motions of the extremity of this nerve in our attention to other objects. See Sect. XVII. 1. 3. on Sleep. Hence the dark fpots, and other ocular fpectra, are more frequently attended to, and remain longer in the eyes of weak people, as after violent exercife, intoxication, or want of fleep.

6. A contraction of the fibres fomewhat greater than ufual introduces pleafurable fenfation into the fyftem, according to the fourth law of animal caufation. Hence the pleafure in the beginning of drunkennefs is owing to the increafed action of the fyftem from the ftimulus of vinous fpirit or of opium. If the contractions be ftill greater in energy or duration, painful fenfations are introduced, as in confequence of great heat, or cauftic applications, or fatigue.

If any part of the fyftem, which is ufed to perpetual activity, as the ftomach, or heart, or the fine veffels of the fkin, acts for a time with lefs energy, another kind of painful fenfation enfues, which is called hunger, or faintnefs, or cold.

This

This occurs in a lefs degree in the locomotive mufcles, and is called wearifomenefs. In the two former kinds of fenfation there is an expenditure of fenforial power, in thefe latter there is an accumulation of it.

7. We have ufed the words exertion of fenforial power as a general term to exprefs either irritation, fenfation, volition, or affociation; that is, to exprefs the activity or motion of the fpirit of animation, at the time it produces the contractions of the fibrous parts of the fyftem. It may be fuppofed that there may exift a greater or lefs mobility of the fibrous parts of our fyftem, or a propenfity to be ftimulated into contraction by the greater or lefs quantity or energy of the fpirit of animation; and that hence if the exertion of the fenforial power be in its natural ftate, and the mobility of the fibres be increafed, the fame quantity of fibrous contraction will be caufed, as if the mobility of the fibres continues in its natural ftate, and the fenforial exertion be increafed.

Thus it may be conceived, that in difeafes accompanied with ftrength, as in inflammatory fevers with arterial ftrength, that the caufe of greater fibrous contraction may exift in the increafed mobility of the fibres, whofe contractions are thence both more forceable and more frequent. And that in difeafes attended with debility, as in nervous fevers, where the fibrous contractions are weaker, and more frequent, it may be

be conceived that the caufe confifts in a decreafe of mobility of the fibres; and that thofe weak conftitutions, which are attended with cold extremities and large pupils of the eyes, may poffefs lefs mobility of the contractile fibres, as well as lefs quantity of exertion of the fpirit of animation.

In anfwer to this mode of reafoning it may be fufficient to obferve, that the contractile fibres confift of inert matter, and when the fenforial power is withdrawn, as in death, they poffefs no power of motion at all, but remain in their laft ftate, whether of contraction or relaxation, and muft thence derive the whole of this property from the fpirit of animation. At the fame time it is not improbable, that the moving fibres of ftrong people may poffefs a capability of receiving or containing a greater quantity of the fpirit of animation than thofe of weak people.

In every contraction of a fibre there is an expenditure of the fenforial power, or fpirit of animation; and where the exertion of this fenforial power has been for fome time increafed, and the mufcles or organs of fenfe have in confequence acted with greater energy, its propenfity to activity is proportionally leffened; which is to be afcribed to the exhauftion or diminution of its quantity. On the contrary, where there has been lefs fibrous contraction than ufual for a certain time, the fenforial power or fpirit of animation becomes accu-

mulated

mulated in the inactive part of the fyftem. Hence vigour fucceeds reft, and hence the propenfity to action of all our organs of fenfe and mufcles is in a ftate of perpetual fluctuation. The irritability for inftance of the retina, that is, its quantity of fenforial power, varies every moment according to the brightnefs or obfcurity of the object laft beheld compared with the prefent one. The fame occurs to our fenfe of heat, and to every part of our fyftem, which is capable of being excited into action.

When this variation of the exertion of the fenforial power becomes much and permanently above or beneath the natural quantity, it becomes a difeafe. If the irritative motions be too great or too little, it fhews that the ftimulus of external things affects this fenforial power too violently or too inertly. If the fenfitive motions be too great or too little, the caufe arifes from the deficient or exuberant quantity of fenfation produced in confequence of the motions of the mufcular fibres or organs of fenfe; if the voluntary actions are difeafed the caufe is to be looked for in the quantity of volition produced in confequence of the defire or averfion occafioned by the painful or pleafurable fenfations above mentioned. And the difeafes of affociation probably depend on the greater or lefs quantity of the other three fenforial powers by which they were formed.

From whence it appears that the propenfity to action,

action, whether it be called irritability, ſenſibility, voluntarity, or aſſociability, is only another mode of expreſſion for the quantity of ſenſorial power reſiding in the organ to be excited. And that on the contrary the words inirritability and inſenſibility, together with inaptitude to voluntary and aſſociate motions, are ſynonymous with deficiency of the quantity of ſenſorial power, or of the ſpirit of animation, reſiding in the organs to be excited.

## II. *Of ſenſorial Exertion.*

1. There are three circumſtances to be attended to in the production of animal motions. 1ſt. The ſtimulus. 2. The ſenſorial power. 3d. The contractile fibre. 1ſt. A ſtimulus, external to the organ, originally induces into action the ſenſorial faculty termed irritation; this produces the contraction of the fibres, which, if it be perceived at all, introduces pleaſure or pain; which in their active ſtate are termed ſenſation; which is another ſenſorial faculty, and occaſionally produces contraction of the fibres; this pleaſure or pain is therefore to be conſidered as another ſtimulus, which may either act alone or in conjunction with the former faculty of the ſenſorium termed irritation. This new ſtimulus of pleaſure or pain either induces into action the ſenſorial faculty

termed fenfation, which then produces the contraction of the fibres; or it introduces defire or averfion, which excite into action another fenforial faculty, termed volition, and may therefore be confidered as another ftimulus, which either alone or in conjunction with one or both of the two former faculties of the fenforium produces the contraction of animal fibres. There is another fenforial power, that of affociation, which perpetually, in conjunction with one or more of the above, and frequently fingly, produces the contraction of animal fibres, and which is itfelf excited into action by the previous motions of contracting fibres.

Now as the fenforial power, termed irritation, refiding in any particular fibres, is excited into exertion by the ftimulus of external bodies acting on thofe fibres; the fenforial power, termed fenfation, refiding in any particular fibres is excited into exertion by the ftimulus of pleafure or pain acting on thofe fibres; the fenforial power, termed volition, refiding in any particular fibres is excited into exertion by the ftimulus of defire or averfion; and the fenforial power, termed affociation, refiding in any particular fibres, is excited into action by the ftimulus of other fibrous motions, which had frequently preceded them. The word ftimulus may therefore be ufed without impropriety of language, for any of thefe four caufes, which excite the four fenforial powers into exertion.

ertion. For though the immediate cauſe of volition has generally been termed *a motive*; and that of irritation only has generally obtained the name of *ſtimulus*; yet as the immediate cauſe, which excites the ſenſorial powers of ſenſation, or of aſſociation, into exertion, have obtained no general name, we ſhall uſe the word ſtimulus for them all.

Hence the quantity of motion produced in any particular part of the animal ſyſtem will be as the quantity of ſtimulus, and the quantity of ſenſorial power, or ſpirit of animation, reſiding in the contracting fibres. Where both theſe quantities are great, *ſtrength* is produced, when that word is applied to the motions of animal bodies. Where either of them is deficient, *weakneſs* is produced, as applied to the motions of animal bodies.

Now as the ſenſorial power, or ſpirit of animation, is perpetually exhauſted by the expenditure of it in fibrous contractions, and is perpetually renewed by the ſecretion or production of it in the brain and ſpinal marrow, the quantity of animal ſtrength muſt be in a perpetual ſtate of fluctuation on this account; and if to this be added the unceaſing variation of all the four kinds of ſtimulus above deſcribed, which produce the exertions of the ſenſorial powers, the ceaſeleſs viciſſitude of animal ſtrength becomes eaſily comprehended.

If the quantity of ſenſorial power remains the ſame, and the quantity of ſtimulus be leſſened, a weakneſs

weakneſs of the fibrous contractions enſues, which may be denominated *debility from defect of ſtimulus.* If the quantity of ſtimulus remains the ſame, and the quantity of ſenſorial power be leſſened, another kind of weakneſs enſues, which may be termed *debility from defect of ſenſorial power*; the former of theſe is called by Dr. Brown, in his Elements of Medicine, direct debility, and the latter indirect debility. The coincidence of ſome parts of this work with correſpondent deductions in the Brunonian Elementa Medicinæ, a work (with ſome exceptions) of great genius, muſt be conſidered as confirmations of the truth of the theory, as they were probably arrived at by different trains of reaſoning.

Thus in thoſe who have been expoſed to cold and hunger there is a deficiency of ſtimulus. While in nervous fever there is a deficiency of ſenſorial power. And in habitual drunkards, in a morning before their uſual potation, there is a deficiency both of ſtimulus and of ſenſorial power. While, on the other hand, in the beginning of intoxication there is an exceſs of ſtimulus; in the hot-ach, after the hands have been immerſed in ſnow, there is a redundancy of ſenſorial power; and in inflammatory diſeaſes with arterial ſtrength, there is an exceſs of both.

Hence if the ſenſorial power be leſſened, while the quantity of ſtimulus remains the ſame, as in nervous fever, the frequency of repetition of the

arterial contractions may continue, but their force in respect to removing obstacles, as in promoting the circulation of the blood, or the velocity of each contraction, will be diminished, that is, the animal strength will be lessened. And secondly, if the quantity of sensorial power be lessened, and the stimulus be increased to a certain degree, as in giving opium in nervous fevers, the arterial contractions may be performed more frequently than natural, yet with less strength.

And thirdly, if the sensorial power continues the same in respect to quantity, and the stimulus be somewhat diminished, as in going into a darkish room, or into a coldish bath, suppose of about eighty degrees of heat, as Buxton-bath, a temporary weakness of the affected fibres is induced, till an accumulation of sensorial power gradually succeeds, and counterbalances the deficiency of stimulus, and then the bath ceases to feel cold, and the room ceases to appear dark; because the fibres of the subcutaneous vessels, or of the organs of sense, act with their usual energy.

A set of muscular fibres may thus be stimulated into violent exertion, that is, they may act frequently, and with their whole sensorial power, but may nevertheless not act strongly; because the quantity of their sensorial power was originally small, or was previously exhausted. Hence a stimulus may be great, and the irritation in

consequence

confequence act with its full force, as in the hot paroxyfms of nervous fever; but if the fenforial power, termed irritation, be fmall in quantity, the force of the fibrous contractions, and the times of their continuance in their contracted ftate, will be proportionally fmall.

In the fame manner in the hot paroxyfm of putrid fevers, which are fhewn in Sect. XXXIII. to be inflammatory fevers with arterial debility, the fenforial power termed fenfation is exerted with great activity, yet the fibrous contractions, which produce the circulation of the blood, are performed without ftrength, becaufe the quantity of fenforial power then refiding in that part of the fyftem is fmall.

Thus in irritative fever with arterial ftrength, that is, with excefs of fpirit of animation, the quantity of exertion during the hot part of the paroxyfm is to be eftimated from the quantity of ftimulus, and the quantity of fenforial power, while in fenfitive (or inflammatory) fever with arterial ftrength, that is, with excefs of fpirit of animation, the violent and forcible actions of the vafcular fyftem during the hot part of the paroxyfm are induced by the exertions of two fenforial powers, which are excited by two kinds of ftimulus. Thefe are the fenforial power of irritation excited by the ftimulus of bodies external to the moving fibres, and the fenforial power of

 fenfation

ſenſation excited by the pain in conſequence of the increaſed contractions of thoſe moving fibres.

And in inſane people in ſome caſes the force of their muſcular actions will be in proportion to the quantity of ſenſorial power, which they poſſeſs, and the quantity of the ſtimulus of deſire or averſion, which excites their volition into action. At the ſame time in other caſes the ſtimulus of pain or pleaſure, and the ſtimulus of external bodies, may excite into action the ſenſorial powers of ſenſation and irritation, and thus add greater force to their muſcular actions.

2. The application of the ſtimulus, whether that ſtimulus be ſome quality of external bodies, or pleaſure or pain, or deſire or averſion, or a link of aſſociation, excites the correſpondent ſenſorial power into action, and this cauſes the contraction of the fibre. On the contraction of the fibre a part of the ſpirit of animation becomes expended, and the fibre ceaſes to contract, though the ſtimulus continues to be applied; till in a certain time the fibre having received a ſupply of ſenſorial power is ready to contract again, if the ſtimulus continues to be applied. If the ſtimulus on the contrary be withdrawn, the ſame quantity of quieſcent ſenſorial power becomes reſident in the fibre as before its contraction; as appears from the readineſs for action of the large locomotive muſcles of the body in a ſhort time after common exertion.

But

But in thofe mufcular fibres, which are fubject to conftant ftimulus, as the arteries, glands, and capillary veffels, another phenomenon occurs, if their accuftomed ftimulus be withdrawn; which is, that the fenforial power becomes accumulated in the contractile fibres, owing to the want of its being perpetually expended, or carried away, by their ufual unremitted contractions. And on this account thofe mufcular fibres become afterwards excitable into their natural actions by a much weaker ftimulus; or into unnatural violence of action by their accuftomed ftimulus, as is feen in the hot fits of intermittent fevers, which are in confequence of the previous cold ones. Thus the minute veffels of the fkin are conftantly ftimulated by the fluid matter of heat; if the quantity of this ftimulus of heat be a while diminifhed, as in covering the hands with fnow, the veffels ceafe to act, as appears from the palenefs of the fkin; if this cold application of fnow be continued but a fhort time, the fenforial power, which had habitually been fupplied to the fibres, becomes now accumulated in them, owing to the want of its being expended by their accuftomed contractions. And thence a lefs ftimulus of heat will now excite them into violent contractions.

If the quiefcence of fibres, which had previoufly been fubject to perpetual ftimulus, continues a longer time; or their accuftomed ftimulus be

more completely withdrawn; the accumulation of ſenſorial power becomes ſtill greater, as in thoſe expoſed to cold and hunger; pain is produced, and the organ gradually dies from the chemical changes, which take place in it; or it is at a great diſtance of time reſtored to action by ſtimulus applied with great caution in ſmall quantity, as happens to ſome larger animals and to many inſects, which during the winter months lie benumbed with cold, and are ſaid to ſleep, and to perſons apparently drowned, or apparently frozen to death. Snails have been ſaid to revive by throwing them into water after having been many years ſhut up in the cabinets of the curious; and eggs and ſeeds in general are reſtored to life after many months of torpor by the ſtimulus of warmth and moiſture.

The inflammation of ſcirrhous tumours, which have long exiſted in a ſtate of inaction, is a proceſs of this kind; as well as the ſenſibility acquired by inflamed tendons and bones, which had at their formation a ſimilar ſenſibility, which had ſo long lain dormant in their uninflamed ſtate.

3. If after long quieſcence from defect of ſtimulus the fibres, which had previouſly been habituated to perpetual ſtimulus, are again expoſed to but their uſual quantity of it; as in thoſe who have ſuffered the extremes of cold or hunger; a violent exertion of the affected organ commences, owing, as above explained, to the great accumulation

lation of ſenſorial power. This violent exertion not only diminiſhes the accumulated ſpirit of animation, but at the ſame time induces pleaſure or pain into the ſyſtem, which, whether it be ſucceeded by inflammation or not, becomes an additional ſtimulus, and acting along with the former one, produces ſtill greater exertions; and thus reduces the ſenſorial power in the contracting fibres beneath its natural quantity.

When the ſpirit of animation is thus exhauſted by uſeleſs exertions, the organ becomes torpid or unexcitable into action, and a ſecond fit of quieſcence ſucceeds that of abundant activity. During this ſecond fit of quieſcence the ſenſorial power becomes again accumulated, and another fit of exertion follows in train. Theſe viciſſitudes of exertion and inertion of the arterial ſyſtem conſtitute the paroxyſms of remittent fevers; or intermittent ones, when there is an interval of the natural action of the arteries between the exacerbations.

In theſe paroxyſms of fevers, which conſiſt of the libration of the arterial ſyſtem between the extremes of exertion and quieſcence, either the fits become leſs and leſs violent from the contractile fibres becoming leſs excitable to the ſtimulus by habit, that is, by becoming accuſtomed to it, as explained below XII. 3. 1. or the whole ſenſorial power becomes exhauſted, and the arteries

ceafe to beat, and the patient dies in the cold part of the paroxyfm. Or fecondly, fo much pain is introduced into the fyftem by the violent contractions of the fibres, that inflammation arifes, which prevents future cold fits by expending a part of the fenforial power in the extenfion of old veffels or the production of new ones, and thus preventing the too great accumulation or exertion of it in other parts of the fyftem; or which by the great increafe of ftimulus excites into great action the whole glandular fyftem as well as the arterial, and thence a greater quantity of fenforial power is produced in the brain, and thus its exhauftion in any peculiar part of the fyftem ceafes to be effected.

4. Or thirdly, in confequence of the painful or pleafurable fenfation above mentioned, defire and averfion are introduced, and inordinate volition fucceeds; which by its own exertions expends fo much of the fpirit of animation, that the two other fenforial faculties, or irritation and fenfation, act fo much more feebly; that the paroxyfms of fever, or that libration between the extremes of exertion and inactivity of the arterial fyftem, gradually fubfides. On this account a temporary infanity is a favourable fign in fevers, as I have had fome opportunities of obferving.

III. *Of*

## III. *Of repeated Stimulus.*

1. When a ſtimulus is repeated more frequently than the expenditure of ſenſorial power can be renewed in the acting organ, the effect of the ſtimulus becomes gradually diminiſhed. Thus if two grains of opium be ſwallowed by a perſon unuſed to ſo ſtrong a ſtimulus, all the vaſcular ſyſtems in the body act with great energy, all the ſecretions and the abſorption from thoſe ſecreted fluids are increaſed in quantity; and pleaſure or pain are introduced into the ſyſtem, which adds an additional ſtimulus to that already too great. After ſome hours the ſenſorial power becomes diminiſhed in quantity, expended by the great activity of the ſyſtem; and thence, when the ſtimulus of the opium is withdrawn, the fibres will not obey their uſual degree of natural ſtimulus, and a conſequent torpor or quieſcence ſucceeds, as is experienced by drunkards, who on the day after a great exceſs of ſpirituous potation feel indigeſtion, head-ache, and general debility.

In this fit of torpor or quieſcence of a part or of the whole of the ſyſtem, an accumulation of the ſenſorial power in the affected fibres is formed, and occaſions a ſecond paroxyſm of exertion by the application only of the natural ſtimulus, and thus a libration of the ſenſorial exertion between one exceſs and the other continues for two or three

three days, where the ftimulus was violent in degree; and for weeks in fome fevers, from the ftimulus of contagious matter.

But if a fecond dofe of opium be exhibited before the fibres have regained their natural quantity of fenforial power, its effect will be much lefs than the former, becaufe the fpirit of animation or fenforial power is in part exhaufted by the previous excefs of exertion. Hence all medicines repeated too frequently gradually lofe their effect, as opium and wine. Many things of difagreeable tafte at firft ceafe to be difagreeable by frequent repetition, as tobacco; grief and pain gradually diminifh, and at length ceafe altogether, and hence life itfelf becomes tolerable.

Befides the temporary diminution of the fpirit of animation or fenforial power, which is naturally ftationary or refident in every living fibre, by a fingle exhibition of a powerful ftimulus, the contractile fibres themfelves, by the perpetual application of a new quantity of ftimulus, before they have regained their natural quantity of fenforial power, appear to fuffer in their capability of receiving fo much as the natural quantity of fenforial power; and hence a permanent deficiency of fpirit of animation takes place, however long the ftimulus may have been withdrawn. On this caufe depends the permanent debility of thofe, who have been addicted to intoxication, the general weaknefs of old age, and the natural debility

debility or inirritability of thofe, who have pale fkins and large pupils of their eyes.

There is a curious phenomenon belongs to this place, which has always appeared difficult of folution; and that is, that opium or aloes may be exhibited in fmall dofes at firft, and gradually increafed to very large ones without producing ftupor or diarrhœa. In this cafe, though the opium and aloes are given in fuch fmall dofes as not to produce intoxication or catharfis, yet they are exhibited in quantities fufficient in fome degree to exhauft the fenforial power, and hence a ftronger and a ftronger dofe is required; otherwife the medicine would foon ceafe to act at all.

On the contrary, if the opium or aloes be exhibited in a large dofe at firft, fo as to produce intoxication or diarrhœa; after a few repetitions the quantity of either of them may be diminifhed, and they will ftill produce this effect. For the more powerful ftimulus diffevers the progreffive catenations of animal motions, defcribed in Sect. XVII. and introduces a new link between them; whence every repetition ftrengthens this new affociation or catenation, and the ftimulus may be gradually decreafed, or be nearly withdrawn, and yet the effect fhall continue; becaufe the fenforial power of affociation or catenation being united with the ftimulus, increafes in energy with every repetition of the catenated circle; and it is by thefe means that all the irritative affociations of motions are originally produced.

Thus

Thus if the Peruvian bark be given in the intervals between the fits of intermittent fever in fuch fmall dofes, as not to prevent the returns of fever, the conftitution ceafes to obey its ftimulus, and the difeafe cannot be cured even by the largeft dofes of bark, unlefs the patient ceafes to take any for a few days previous to the exhibition of larger dofes. But if large dofes be at firft exhibited, fo as to prevent the return of fever, fmall ones taken afterwards will continue to prevent the return of it.

2. When a ftimulus is repeated at fuch diftant intervals of time, that the natural quantity of fenforial power becomes completely reftored in the acting fibres, it will act with the fame energy as when firft applied. Hence thofe who have lately accuftomed themfelves to large dofes of opium by beginning with fmall ones, and gradually increafing them, and repeating them frequently, as mentioned in the preceding paragraphs; if they intermit the ufe of it for a few days only, muft begin again with as fmall dofes as they took at firft, otherwife they will experience the inconveniences of intoxication.

On this circumftance depend the conftant unfailing effects of the various kinds of ftimulus, which excite into action all the vafcular fyftems in the body; the arterial, venous, abforbent, and glandular veffels, are brought into perpetual unwearied action by the fluids, which are adapted

to ſtimulate them; but theſe have the ſenſorial power of aſſociation added to that of irritation, and even in ſome degree that of ſenſation, and even of volition, as will be ſpoken of in their places; and life itſelf is thus carried on by the production of ſenſorial power being equal to its waſte or expenditure in the perpetual movement of the vaſcular organization.

3. When a ſtimulus is repeated at uniform intervals of time with ſuch diſtances between them, that the expenditure of ſenſorial power in the acting fibres becomes completely renewed, the effect is produced with greater facility or energy. For the ſenſorial power of aſſociation is combined with the ſenſorial power of irritation, or, in common language, the acquired habit aſſiſts the power of the ſtimulus.

This circumſtance not only obtains in the annual and diurnal catenations of animal motions explained in Sect. XXXVI. but in every leſs circle of actions or ideas, as in the burthen of a ſong, or the iterations of a dance; and conſtitutes the pleaſure we receive from repetition and imitation; as treated of in Sect. XXII. 2.

4. When a ſtimulus has been many times repeated at uniform intervals, ſo as to produce the complete action of the organ, it may then be gradually diminiſhed, or totally withdrawn, and the action of the organ will continue. For the ſenſorial power of aſſociation becomes united with that

that of irritation, and by frequent repetition becomes at length of fufficient energy to carry on the new link in the circle of actions, without the irritation which at firft introduced it.

Hence, when the bark is given at ftated intervals for the cure of intermittent fevers, if fixty grains of it be given every three hours for the twenty-four hours preceding the expected paroxyfm, fo as to ftimulate the defective part of the fyftem into action, and by that means to prevent the torpor or quiefcence of the fibres, which conftitutes the cold fit; much lefs than half the quantity, given before the time at which another paroxyfm of quiefcence would have taken place, will be fufficient to prevent it; becaufe now the fenforial power, termed affociation, acts in a twofold manner. Firft, in refpect to the period of the catenation in which the cold fit was produced, which is now diffevered by the ftronger ftimulus of the firft dofes of the bark; and, fecondly, becaufe each dofe of bark being repeated at periodical times, has its effect increafed by the fenforial faculty of affociation being combined with that of irritation.

Now, when fixty grains of Peruvian bark are taken twice a day, fuppofe at ten o'clock and at fix, for a fortnight, the irritation excited by this additional ftimulus becomes a part of the diurnal circle of actions, and will at length carry on the increafed action of the fyftem without the affift-

ance of the ſtimulus of the bark. On this theory the bitter medicines, chalybeates, and opiates in appropriated doſes, exhibited for a fortnight, give permanent ſtrength to pale feeble children, and other weak conſtitutions.

5. When a defect of ſtimulus, as of heat, recurs at certain diurnal intervals, which induces ſome torpor or quieſcence of a part of the ſyſtem, the diurnal catenation of actions becomes diſordered, and a new aſſociation with this link of torpid action is formed; on the next period the quantity of quieſcence will be increaſed, ſuppoſe the ſame defect of ſtimulus to recur, becauſe now the new aſſociation conſpires with the defective irritation in introducing the torpid action of this part of the diurnal catenation. In this manner many fever-fits commence, where the patient is for ſome days indiſpoſed at certain hours, before the cold paroxyſm of fever is completely formed. See Sect. XVII. 3. 3. on Catenation of Animal Motions.

6. If a ſtimulus, which at firſt excited the affected organ into ſo great exertion as to produce ſenſation, be continued for a certain time, it will ceaſe to produce ſenſation both then and when repeated, though the irritative motions in conſequence of it may continue or be re-excited.

Many catenations of irritative motions were at firſt ſucceeded by ſenſation, as the apparent motions of objects when we walk paſt them, and probably

probably the vital motions themſelves in the early ſtate of our exiſtence. But as thoſe ſenſations were followed by no movements of the ſyſtem in conſequence of them, they gradually ceaſed to be produced, not being joined to any ſucceeding link of catenation. Hence contagious matter, which has for ſome weeks ſtimulated the ſyſtem into great and permanent ſenſation, ceaſes afterwards to produce general ſenſation, or inflammation, though it may ſtill induce topical irritations. See Sect. XXXIII. 2. 8. XIX. 10.

Our abſorbent ſyſtem then ſeems to receive thoſe contagious matters, which it has before experienced, in the ſame manner as it imbibes common moiſture or other fluids; that is, without being thrown into ſo violent action as to produce ſenſation; the conſequence of which is an increaſe of daily energy or activity, till inflammation and its conſequences ſucceed.

7. If a ſtimulus excites an organ into ſuch violent contractions as to produce ſenſation, the motions of which organ had not uſually produced ſenſation, this new ſenſorial power, added to the irritation occaſioned by the ſtimulus, increaſes the activity of the organ. And if this activity be catenated with the diurnal circle of actions, an increaſing inflammation is produced; as in the evening paroxyſms of ſmall-pox, and other fevers with inflammation. And hence ſcirrhous tumours, tendons and membranes, and probably the

the arteries themſelves become inflamed, when they are ſtrongly ſtimulated.

## IV. *Of Stimulus greater than natural.*

1. A quantity of ſtimulus greater than natural, producing an increaſed exertion of ſenſorial power, whether that exertion be in the mode of irritation, ſenſation, volition, or aſſociation, diminiſhes the general quantity of it. This fact is obſervable in the progreſs of intoxication, as the increaſed quantity or energy of the irritative motions, owing to the ſtimulus of vinous ſpirit, introduces much pleaſurable ſenſation into the ſyſtem, and much exertion of muſcular or ſenſual motions in conſequence of this increaſed ſenſation; the voluntary motions, and even the aſſociate ones, become much impaired or diminiſhed; and delirium and ſtaggering ſucceed. See Sect. XXI. on Drunkenneſs. And hence the great proſtration of the ſtrength of the locomotive muſcles in ſome fevers, is owing to the exhauſtion of ſenſorial power by the increaſed action of the arterial ſyſtem.

In like manner a ſtimulus greater than natural, applied to a part of the ſyſtem, increaſes the exertion of ſenſorial power in that part, and diminiſhes it in ſome other part. As in the commencement of ſcarlet fever, it is uſual to ſee

great rednefs and heat on the faces and breafts of children, while at the fame time their feet are colder than natural; partial heats are obfervable in other fevers with debility, and are generally attended with torpor or quiefcence of fome other part of the fyftem. But thefe partial exertions of fenforial power are fometimes attended with increafed partial exertions in other parts of the fyftem, which fympathize with them, as the flufhing of the face after a full meal. Both thefe therefore are to be afcribed to fympathetic affociations, explained in Sect. XXXV. and not to general exhauftion or accumulation of fenforial power.

2. A quantity of ftimulus greater than natural, producing an increafed exertion of fenforial power in any particular organ, diminifhes the quantity of it in that organ. This appears from the contractions of animal fibres being not fo eafily excited by a lefs ftimulus after the organ has been fubjected to a greater. Thus after looking at any luminous object of a fmall fize, as at the fetting fun, for a fhort time, fo as not much to fatigue the eye, this part of the retina becomes lefs fenfible to fmaller quantities of light; hence when the eyes are turned on other lefs luminous parts of the fky, a dark fpot is feen refembling the fhape of the fun, or other luminous object which we laft behold. See Sect. XL. No. 2.

Thus we are fome time before we can diftinguifh objects in an obfcure room after coming

from

from bright day-light, though the iris prefently contracts itfelf. We are not able to hear weak founds after loud ones. And the ftomachs of thofe who have been much habituated to the ftronger ftimulus of fermented or fpirituous liquors, are not excited into due action by weaker ones.

3. A quantity of ftimulus fomething greater than the laft mentioned, or longer continued, induces the organ into fpafmodic action, which ceafes and recurs alternately. Thus on looking for a time on the fetting fun, fo as not greatly to fatigue the fight, a yellow fpectrum is feen when the eyes are clofed and covered, which continues for a time, and then difappears and recurs repeatedly before it entirely vanifhes. See Sect. XL. No. 5. Thus the action of vomiting ceafes and is renewed by intervals, although the emetic drug is thrown up with the firft effort. A tenefmus continues by intervals fome time after the exclufion of acrid excrement; and the pulfations of the heart of a viper are faid to continue fome time after it is cleared from its blood.

In thefe cafes the violent contractions of the fibres produce pain according to law 4; and this pain conftitutes an additional kind or quantity of excitement, which again induces the fibres into contraction, and which painful excitement is again renewed, and again induces contractions of the fibres with gradually diminifhing effect.

4. A quantity of ftimulus greater than that laft mentioned, or longer continued, induces the antagonift mufcles into fpafmodic action. This is beautifully illuftrated by the ocular fpectra defcribed in Sect. XL. No. 6. to which the reader is referred. From thofe experiments there is reafon to conclude that the fatigued part of the retina throws itfelf into a contrary mode of action like ofcitation or pandiculation, as foon as the ftimulus, which has fatigued it, is withdrawn; but that it ftill remains liable to be excited into action by any other colours except the colour with which it has been fatigued. Thus the yawning and ftretching the limbs after a continued action or attitude feems occafioned by the antagonift mufcles being ftimulated by their extenfion during the contractions of thofe in action, or in the fituation in which that action laft left them.

5. A quantity of ftimulus greater than the laft, or longer continued, induces variety of convulfions or fixed fpafms either of the affected organ or of the moving fibres in the other parts of the body. In refpect to the fpectra in the eye, this is well illuftrated in No. 7 and 8, of Sect. XL. Epileptic convulfions, as the emprofthotonos and opifthotonos, with the cramp of the calf of the leg, locked jaw, and other cataleptic fits, appear to originate from pain, as fome of thefe patients fcream aloud before the convulfion takes place; which

which ſeems at firſt to be an effort to relieve painful ſenſation, and afterwards an effort to prevent it.

In theſe caſes the violent contractions of the fibres produce ſo much pain, as to conſtitute a perpetual excitement; and that in ſo great a degree as to allow but ſmall intervals of relaxation of the contracting fibres as in convulſions, or no intervals at all as in fixed ſpaſms.

6. A quantity of ſtimulus greater than the laſt, or longer continued, produces a paralyſis of the organ. In many caſes this paralyſis is only a temporary effect, as on looking long on a ſmall area of bright red ſilk placed on a ſheet of white paper on the floor in a ſtrong light, the red ſilk gradually becomes paler, and at length diſappears; which evinces that a part of the retina, by being violently excited, becomes for a time unaffected by the ſtimulus of that colour. Thus cathartic medicines, opiates, poiſons, contagious matter, ceaſe to influence our ſyſtem after it has been habituated to the uſe of them, except by the exhibition of increaſed quantities of them; our fibres not only become unaffected by ſtimuli, by which they have previouſly been violently irritated, as by the matter of the ſmall-pox or meaſles; but they alſo become unaffected by ſenſation, where the violent exertions, which diſabled them, were in conſequence of too great quantity of ſenſation. And laſtly the fibres, which become diſobedient to volition,

are probably difabled by their too violent exertions in confequence of too great a quantity of volition.

After every exertion of our fibres a temporary paralyfis fucceeds, whence the intervals of all mufcular contractions, as mentioned in No. 3 and 4 of this Section; the immediate caufe of thefe more permanent kinds of paralyfis is probably owing in the fame manner to the too great exhauftion of the fpirit of animation in the affected part; fo that a ftronger ftimulus is required, or one of a different kind from that, which occafioned thofe too violent contractions, to again excite the affected organ into activity; and if a ftronger ftimulus could be applied, it muft again induce paralyfis.

For thefe powerful ftimuli excite pain at the fame time, that they produce irritation; and this pain not only excites fibrous motions by its ftimulus, but it alfo produces volition; and thus all thefe ftimuli acting at the fame time, and fometimes with the addition of their affociations, produce fo great exertion as to expend the whole of the fenforial power in the affected fibres.

### V. *Of Stimulus lefs than natural.*

1. A quantity of ftimulus lefs than natural, producing a decreafed exertion of fenforial power, occafions

occaſions an accumulation of the general quantity of it. This circumſtance is obſervable in the hæmiplegia, in which the patients are perpetually moving the muſcles, which are unaffected. On this account we awake with greater vigour after ſleep, becauſe during ſo many hours, the great uſual expenditure of ſenſorial power in the performance of voluntary actions, and in the exertions of our organs of ſenſe, in conſequence of the irritations occaſioned by external objects had been ſuſpended, and a conſequent accumulation had taken place.

In like manner the exertion of the ſenſorial power leſs than natural in one part of the ſyſtem, is liable to produce an increaſe of the exertion of it in ſome other part. Thus by the action of vomiting, in which the natural exertion of the motions of the ſtomach are deſtroyed or diminiſhed, an increaſed abſorption of the pulmonary and cellular lymphatics is produced, as is known by the increaſed abſorption of the fluid depoſited in them in dropſical caſes. But theſe partial quieſcences of ſenſorial power are alſo ſometimes attended with other partial quieſcences, which ſympathize with them, as cold and pale extremities from hunger. Theſe therefore are to be aſcribed to the aſſociations of ſympathy explained in Sect. XXXV. and not to the general accumulation of ſenſorial power.

2. A quantity of ftimulus lefs than natural, applied to fibres previoufly accuftomed to perpetual ftimulus, is fucceeded by accumulation of fenforial power in the affected organ. The truth of this propofition is evinced, becaufe a ftimulus lefs than natural, if it be fomewhat greater than that above mentioned, will excite the organ fo circumftanced into violent activity. Thus on a frofty day with wind, the face of a perfon expofed to the wind is at firft pale and fhrunk; but on turning the face from the wind, it becomes foon of a glow with warmth and flufhing. The glow of the fkin in emerging from the cold-bath is owing to the fame caufe.

It does not appear, that an accumulation of fenforial power above the natural quantity is acquired by thofe mufcles, which are not fubject to perpetual ftimulus, as the locomotive mufcles: thefe, after the greateft fatigue, only acquire by reft their ufual aptitude to motion; whereas the vafcular fyftem, as the heart and arteries, after a fhort quiefcence, are thrown into violent action by their natural quantity of ftimulus.

Neverthelefs by this accumulation of fenforial power during the application of decreafed ftimulus, and by the exhauftion of it during the action of increafed ftimulus, it is wifely provided, that the actions of the vafcular mufcles and organs of fenfe are not much deranged by fmall variations of ftimulus; as the quantity of fenforial

power

power becomes in some meafure inverfely as the quantity of ftimulus.

3. A quantity of ftimulus lefs than that mentioned above, and continued for fome time, induces pain in the affected organ, as the pain of cold in the hands, when they are immerfed in fnow, is owing to a deficiency of the ftimulation of heat. Hunger is a pain from the deficiency of the ftimulation of food. Pain in the back at the commencement of ague-fits, and the head-achs which attend feeble people, are pains from defect of ftimulus, and are hence relieved by opium, effential oils, fpirit of wine.

As the pains, which originate from defect of ftimulus, only occur in thofe parts of the fyftem, which have been previoufly fubjected to perpetual ftimulus; and as an accumulation of fenforial power is produced in the quiefcent organ along with the pain, as in cold or hunger, there is reafon to believe, that the pain is owing to the accumulation of fenforial power. For, in the locomotive mufcles, in the retina of the eye, and other organs of fenfe, no pain occurs from the abfence of ftimulus, nor any great accumulation of fenforial power beyond their natural quantity, fince thefe organs have not been ufed to a perpetual fupply of it. There is indeed a greater accumulation occurs in the organ of vifion after its quiefcence, becaufe it is fubject to more conftant ftimulus.

4. A certain quantity of ſtimulus leſs than natural induces the moving organ into feebler and more frequent contractions, as mentioned in No. I. 4. of this Section. For each contraction moving through a leſs ſpace, or with leſs force, that is, with leſs expenditure of the ſpirit of animation, is ſooner relaxed, and the ſpirit of animation derived at each interval into the acting fibres being leſs, theſe intervals likewiſe become ſhorter. Hence the tremours of the hands of people accuſtomed to vinous ſpirit, till they take their uſual ſtimulus; hence the quick pulſe in fevers attended with debility, which is greater than in fevers attended with ſtrength; in the latter the pulſe ſeldom beats above 120 times in a minute, in the former it frequently exceeds 140.

It muſt be obſerved, that in this and the two following articles the decreaſed action of the ſyſtem is probably more frequently occaſioned by deficiency in the quantity of ſenſorial power, than in the quantity of ſtimulus. Thus thoſe feeble conſtitutions which have large pupils of their eyes, and all who labour under nervous fevers, ſeem to owe their want of natural quantity of activity in the ſyſtem to the deficiency of ſenſorial power; ſince, as far as can be ſeen, they frequently poſſeſs the natural quantity of ſtimulus.

5. A certain quantity of ſtimulus, leſs than that above mentioned, inverts the order of ſucceſſive fibrous contractions; as in vomiting the vermicular motions of the ſtomach and duodenum

are inverted, and their contents ejected, which is probably owing to the exhaustion of the spirit of animation in the acting muscles by a previous excessive stimulus, as by the root of ipecacuanha, and the consequent defect of sensorial power. The same retrograde motions affect the whole intestinal canal in ileus; and the œsophagus in globus hystericus. See this further explained in Sect. XXIX. No. 11. on Retrograde Motions.

I must observe, also, that something similar happens in the production of our ideas, or sensual motions, when they are too weakly excited; when any one is thinking intensely about one thing, and carelessly conversing about another, he is liable to use the word of a contrary meaning to that which he designed, as cold weather for hot weather, summer for winter.

6. A certain quantity of stimulus, less than that above mentioned, is succeeded by paralysis, first of the voluntary and sensitive motions, and afterwards of those of irritation and of association, which constitutes death.

### VI. *Cure of increased Exertion.*

1. The cure, which nature has provided for the increased exertion of any part of the system, consists in the consequent expenditure of the sensorial power. But as a greater torpor follows this exhaustion

exhauſtion of ſenſorial power, as explained in the next paragraph, and a greater exertion ſucceeds this torpor, the conſtitution frequently ſinks under theſe increaſing librations between exertion and quieſcence; till at length complete quieſcence, that is, death, cloſes the ſcene.

For, during the great exertion of the ſyſtem in the hot fit of fever, an increaſe of ſtimulus is produced from the greater momentum of the blood, the greater diſtention of the heart and arteries, and the increaſed production of heat, by the violent actions of the ſyſtem occaſioned by this augmentation of ſtimulus, the ſenſorial power becomes diminiſhed in a few hours much beneath its natural quantity, the veſſels at length ceaſe to obey even theſe great degrees of ſtimulus, as ſhewn in Sect. XL. 9. 1. and a torpor of the whole or of a part of the ſyſtem enſues.

Now as this ſecond cold fit commences with a greater deficiency of ſenſorial power, it is alſo attended with a greater deficiency of ſtimulus than in the preceding cold fit, that is, with leſs momentum of blood, leſs diſtention of the heart. On this account the ſecond cold fit becomes more violent and of longer duration than the firſt; and as a greater accumulation of ſenſorial power muſt be produced before the ſyſtem of veſſels will again obey the diminiſhed ſtimulus, it follows, that the ſecond hot fit of fever will be more violent than the former one. And that unleſs ſome

other caufes counteract either the violent exertions in the hot fit, or the great torpor in the cold fit, life will at length be extinguifhed by the expenditure of the whole of the fenforial power. And from hence it appears, that the true means of curing fevers muft be fuch as decreafe the action of the fyftem in the hot fit, and increafe it in the cold fit; that is, fuch as prevent the too great diminution of fenforial power in the hot fit, and the too great accumulation of it in the cold one.

2. Where the exertion of the fenforial powers is much increafed, as in the hot fits of fever or inflammation, the following are the ufual means of relieving it. Decreafe the irritations by blood-letting, and other evacuations; by cold water taken into the ftomach, or injected as an enema, or ufed externally; by cold air breathed into the lungs, and diffufed over the fkin; with food of lefs ftimulus than the patient has been accuftomed to.

3. As a cold fit, or paroxyfm of inactivity of fome parts of the fyftem, generally precedes the hot fit, or paroxyfm of exertion, by which the fenforial power becomes accumulated, this cold paroxyfm fhould be prevented by ftimulant medicines and diet, as wine, opium, bark, warmth, cheerfulnefs, anger, furprife.

4. Excite into greater action fome other part of the fyftem, by which means the fpirit of animation may be in part expended, and thence the

inordinate

inordinate actions of the difeafed part may be leffened. Hence when a part of the fkin acts violently, as of the face in the eruption of the fmall-pox, if the feet be cold they fhould be covered. Hence the ufe of a blifter applied near a topical inflammation. Hence opium and warm bath relieve pains both from excefs and defect of ftimulus.

5. Firft increafe the general ftimulation above its natural quantity, which may in fome degree exhauft the fpirit of animation, and then decreafe the ftimulation beneath its natural quantity. Hence after fudorific medicines and warm air, the application of refrigerants may have greater effect, if they could be adminiftered without danger of producing too great torpor of fome part of the fyftem; as frequently happens to people in health from coming out of a warm room into the cold air, by which a topical inflammation in confequence of torpor of the mucous membrane of the noftril is produced, and is termed a cold in the head.

## VII. *Cure of decreafed Exertion.*

1. WHERE the exertion of the fenforial powers is much decreafed, as in the cold fits of fever, a gradual accumulation of the fpirit of animation takes place; as occurs in all cafes where inacti-

vity

vity or torpor of a part of the fyftem exifts; this accumulation of fenforial power increafes, till ftimuli lefs than natural are fufficient to throw it into action, then the cold fit ceafes; and from the action of the natural ftimuli a hot one fucceeds with increafed activity of the whole fyftem.

So in fainting fits, or fyncope, there is a temporary deficiency of fenforial exertion, and a confequent quiefcence of a great part of the fyftem. This quiefcence continues, till the fenforial power becomes again accumulated in the torpid organs; and then the ufual diurnal ftimuli excite the revivefcent parts again into action; but as this kind of quiefcence continues but a fhort time compared to the cold paroxyfm of an ague, and lefs affects the circulatory fyftem, a lefs fuperabundancy of exertion fucceeds in the organs previoufly torpid, and a lefs excefs of arterial activity. See Sect. XXXIV. 1. 6.

2. In the difeafes occafioned by a defect of fenforial exertion, as in cold fits of ague, hyfteric complaint, and nervous fever, the following means are thofe commonly ufed. 1. Increafe the ftimulation above its natural quantity for fome weeks, till a new habit of more energetic contraction of the fibres is eftablifhed. This is to be done by wine, opium, bark, fteel, given at exact periods, and in appropriate quantities; for if thefe medicines be given in fuch quantity, as to induce the leaft degree of intoxication, a debility

debility fucceeds from the ufelefs exhauftion of fpirit of animation in confequence of too great exertion of the mufcles or organs of fenfe. To thefe irritative ftimuli fhould be added the fenfitive ones of cheerful ideas, hope, affection.

3. Change the kinds of ftimulus. The habits acquired by the conftitution depend on fuch nice circumftances, that when one kind of ftimulus ceafes to excite the fenforial power into the quantity of exertion neceffary to health, it is often fufficient to change the ftimulus for another apparently fimilar in quantity and quality. Thus when wine ceafes to ftimulate the conftitution, opium in appropriate dofes fupplies the defect; and the contrary. This is alfo obferved in the effects of cathartic medicines, when one lofes its power, another, apparently lefs efficacious, will fucceed. Hence a change of diet, drink, and ftimulating medicines, is often advantageous in difeafes of debility.

4. Stimulate the organs, whofe motions are affociated with the torpid parts of the fyftem. The actions of the minute veffels of the various parts of the external fkin are not only affociated with each other, but are ftrongly affociated with thofe of fome of the internal membranes, and particularly of the ftomach. Hence when the exertion of the ftomach is lefs than natural, and indigeftion and heartburn fucceed, nothing fo certainly removes thefe fymptoms as the ftimulus

of

of a blifter on the back. The coldnefs of the extremities, as of the nofe, ears, or fingers, are hence the beft indication for the fuccefsful application of blifters.

5. Decreafe the ftimulus for a time. By leffening the quantity of heat for a minute or two by going into the cold bath, a great accumulation of fenforial power is produced; for not only the minute veffels of the whole external fkin for a time become inactive, as appears by their palenefs; but the minute veffels of the lungs lofe much of their activity alfo by concert with thofe of the fkin, as appears from the difficulty of breathing at firft going into cold water. On emerging from the bath the fenforial power is thrown into great exertion by the ftimulus of the common degree of the warmth of the atmofphere, and a great production of animal heat is the confequence. The longer a perfon continues in the cold bath the greater muft be the prefent inertion of a great part of the fyftem, and in confequence a greater accumulation of fenforial power. Whence M. Pomè recommends fome melancholy patients to be kept from two to fix hours in fpring-water, and in baths ftill colder.

6. Decreafe the ftimulus for a time below the natural, and then increafe it above natural. The effect of this procefs, improperly ufed, is feen in giving much food, or applying much warmth, to thofe who have been previoufly expofed to

great hunger, or to great cold. The accumulated fenforial power is thrown into fo violent exertion, that inflammations and mortifications fupervene, and death clofes the cataftrophe. In many difeafes this method is the moft fuccefsful; hence the bark in agues produces more certain effect after the previous exhibition of emetics. In difeafes attended with violent pain, opium has double the effect, if venefection and a cathartic have been previoufly ufed. On this feems to have been founded the fuccefsful practice of Sydenham, who ufed venefection and a cathartic in chlorofis before the exhibition of the bark, fteel, and opiates.

7. Prevent any unneceffary expenditure of fenforial power. Hence in fevers with debility, a decumbent pofture is preferred, with filence, little light, and fuch a quantity of heat as may prevent any chill fenfation, or any coldnefs of the extremities. The pulfe of patients in fevers with debility increafes in frequency above ten pulfations in a minute on their rifing out of bed. For the expenditure of fenforial power to preferve an erect pofture of the body adds to the general deficiency of it, and thus affects the circulation.

8. The longer in time and the greater in degree the quiefcence or inertion of an organ has been, fo that it ftill retains life or excitability, the lefs ftimulus fhould at firft be applied to it. The

quantity

quantity of ſtimulation is a matter of great nicety to determine, where the torpor or quieſcence of the fibres has been experienced in a great degree, or for a conſiderable time, as in cold fits of the ague, in continued fevers with great debility, or in people famiſhed at ſea, or periſhing with cold. In the two laſt caſes, very minute quantities of food ſhould be firſt ſupplied, and very few additional degrees of heat. In the two former caſes, but little ſtimulus of wine or medicine, above what they had been lately accuſtomed to, ſhould be exhibited, and this at frequent and ſtated intervals; ſo that the effect of one quantity may be obſerved before the exhibition of another.

If theſe circumſtances are not attended to, as the ſenſorial power becomes accumulated in the quieſcent fibres, an inordinate exertion takes place by the increaſe of ſtimulus acting on the accumulated quantity of ſenſorial power, and either the paralyſis, or death of the contractile fibres enſues, from the total expenditure of the ſenſorial power in the affected organ, owing to this increaſe of exertion, like the debility after intoxication. Or, ſecondly, the violent exertions above mentioned produce painful ſenſation, which becomes a new ſtimulus, and by thus producing inflammation, and increaſing the activity of the fibres already too great, ſooner exhauſts the whole of the ſenſorial power in the acting organ, and

 mortification,

mortification, that is, the death of the part, fupervenes.

Hence there have been many inftances of people, whofe limbs have been long benumbed by expofure to cold, who have loft them by mortification on their being too haftily brought to the fire; and of others, who were nearly famifhed at fea, who have died foon after having taken not more than an ufual meal of food. I have heard of two well-attefted inftances of patients in the cold fit of ague, who have died from the exhibition of gin and vinegar, by the inflammation which enfued. And in many fevers attended with debility, the unlimited ufe of wine, and the wanton application of blifters, I believe, has deftroyed numbers by the debility confequent to too great ftimulation, that is, by the exhauftion of the fenforial power by its inordinate exertion.

Wherever the leaft degree of intoxication exifts, a proportional debility is the confequence; but there is a golden rule by which the neceffary and ufeful quantity of ftimulus in fevers with debility may be afcertained. When wine or beer is exhibited either alone or diluted with water, if the pulfe becomes flower the ftimulus is of a proper quantity; and fhould be repeated every two or three hours, or when the pulfe again becomes quicker.

In the chronical debility brought on by drinking fpirituous or fermented liquors, there is ano-

ther

ther golden rule by which I have fuccefsfully directed the quantity of fpirit which they may fafely leffen, for there is no other means by which they can recover their health. It fhould be premifed, that where the power of digeftion in thefe patients is totally deftroyed, there is not much reafon to expect a return to healthful vigour.

I have directed feveral of thefe patients to omit one fourth part of the quantity of vinous fpirit they have been lately accuftomed to, and if in a fortnight their appetite increafes, they are advifed to omit another fourth part; but if they perceive that their digeftion becomes impaired from the want of this quantity of fpirituous potation, they are advifed to continue as they are, and rather bear the ills they have, than rifk the encounter of greater. At the fame time flefh-meat with or without fpice is recommended, with Peruvian bark and fteel in fmall quantities between their meals, and half a grain of opium, or a grain, with five or eight grains of rhubarb at night.

### VIII. *Conclufion.*

It may be afked, if ftimulus exhaufts the fenforial power, can an increafe of it ever be ufed with advantage, where the fenforial power is already in too fmall quantity? We muft recollect,

that the ſenſorial power is produced in the brain and ſpinal marrow by the fibrous actions of thoſe glands like other ſecretions: and that hence an increaſed action of theſe glands by an adapted ſtimulus, or by aſſociation of motions, may increaſe the quantity of ſenſorial power, which increaſed actions of the ſyſtem may be continued by habit, after the ſtimulus is withdrawn. Thus ſome kinds of ſtimuli affect particular parts of the ſyſtem, as bliſters affect the ſkin, and the ſtomach by its aſſociation with the ſkin; emetics affect the ſtomach, cathartics the inteſtines; and ſea-ſalt the perſpirable glands or capillaries: but it is probable, that wine and opium affect the whole ſyſtem; and, when given in ſmall repeated quantities, that they increaſe the ſecretion of ſenſorial power, either by their immediate ſtimulus or by aſſociation, and that the ſtrength of convaleſcents is recruited, as they are thus enabled to digeſt more food, and that of a ſomewhat more ſtimulating quality. The Peruvian bark, and arſenic, in the cure of agues, probably act in a ſimilar manner on the ſtomach, and on the parts aſſociated with it, ſo as to increaſe their powers of action; but not on the whole ſyſtem, as general heat is not produced by them.

SECT.

# SECT. XIII.

## OF VEGETABLE ANIMATION.

I. 1. *Vegetables are irritable, mimosa, dionæa muscipula. Vegetable secretions.* 2. *Vegetable buds are inferior animals, are liable to greater or less irritability.* II. *Stamens and pistils of plants shew marks of sensibility.* III. *Vegetables possess some degree of volition.* IV. *Motions of plants are associated like those of animals.* V. 1. *Vegetable structure like that of animals, their anthers and stigmas are living creatures. Male flowers of Vallisneria.* 2. *Whether vegetables possess ideas? They have organs of sense, as of touch and smell, and ideas of external things?*

I. 1. THE fibres of the vegetable world, as well as those of the animal, are excitable into a variety of motions by irritations of external objects. This appears particularly in the mimosa or sensitive plant, whose leaves contract on the slightest injury; the dionæa muscipula, which was lately brought over from the marshes of America, presents us with another curious instance of vegetable irritability; its leaves are armed with spines on their upper edge, and are spread on the ground around the stem; when an insect creeps on any of them in its passage to the flower or seed, the leaf shuts up like a steel rat-trap, and

 destroys

deſtroys its enemy. See Botanic Garden, Part II. note on Silene.

The various ſecretions of vegetables, as of odour, fruit, gum, reſin, wax, honey, ſeem brought about in the ſame manner as in the glands of animals: the taſteleſs moiſture of the earth is converted by the hop-plant into a bitter juice; as by the caterpillar in the nutſhell the ſweet kernel is converted into a bitter powder. While the power of abſorption in the roots and barks of vegetables is excited into action by the fluids applied to their mouths like the lacteals and lymphatics of animals.

2. The individuals of the vegetable world may be conſidered as inferior or leſs perfect animals; a tree is a congeries of many living buds, and in this reſpect reſembles the branches of coralline, which are a congeries of a multitude of animals. Each of theſe buds of a tree has its proper leaves or petals for lungs, produces its viviparous or its oviparous offspring in buds or ſeeds; has its own roots, which extending down the ſtem of the tree are interwoven with the roots of the other buds, and form the bark, which is the only living part of the ſtem, is annually renewed, and is ſuperinduced upon the former bark, which then dies, and with its ſtagnated juices gradually hardening into wood forms the concentric circles, which we ſee in blocks of timber.

The following circumſtances evince the individuality

duality of the buds of trees. Firſt, there are many trees, whoſe whole internal wood is periſhed, and yet the branches are vegete and healthy. Secondly, the fibres of the barks of trees are chiefly longitudinal, reſembling roots, as is beautifully ſeen in thoſe prepared barks, that were lately brought from Otaheite. Thirdly, in horizontal wounds of the bark of trees, the fibres of the upper lip are always elongated downwards like roots, but thoſe of the lower lip do not approach to meet them. Fourthly, if you wrap wet moſs round any joint of a vine, or cover it with moiſt earth, roots will ſhoot out from it. Fifthly, by the inoculation or ingrafting of trees many fruits are produced from one ſtem. Sixthly, a new tree is produced from a branch plucked from an old one, and ſet in the ground. Whence it appears that the buds of deciduous trees are ſo many annual plants, that the bark is a contexture of the caudexes of each individual bud; which conſiſts of a leaf or plumula at top, of a radicle below, and of a caudex, which joins theſe together, and conſtitutes the bark of the tree, and that the internal wood is of no other uſe but to ſupport them in the air, and that thus they reſemble the animal world in their individuality.

The irritability of plants, like that of animals, appears liable to be increaſed or decreaſed by habit; for thoſe trees or ſhrubs, which are brought from a colder climate to a warmer, put out their leaves

leaves and bloſſoms a fortnight ſooner than the indigenous ones.

Profeſſor Kalm, in his Travels in New York, obſerves that the apple-trees brought from England bloſſom a fortnight ſooner than the native ones. In our country the ſhrubs, that are brought a degree or two from the north, are obſerved to flouriſh better than thoſe, which come from the ſouth. The Siberian barley and cabbage are ſaid to grow larger in this climate than the ſimilar more ſouthern vegetables. And our hoards of roots, as of potatoes and onions, germinate with leſs heat in ſpring, after they have been accuſtomed to the winter's cold, than in autumn after the ſummer's heat.

II. The ſtamens and piſtils of flowers ſhew evident marks of ſenſibility, not only from many of the ſtamens and ſome piſtils approaching towards each other at the ſeaſon of impregnation, but from many of them cloſing their petals and calyxes during the cold parts of the day. For this cannot be aſcribed to irritation, becauſe cold means a defect of the ſtimulus of heat; but as the want of accuſtomed ſtimuli produces pain, as in coldneſs, hunger, and thirſt of animals, theſe motions of vegetables in cloſing up their flowers muſt be aſcribed to the diſagreeable ſenſation, and not to the irritation of cold. Others cloſe up their leaves during dark-

nefs, which, like the former, cannot be owing to irritation, as the irritating material is withdrawn.

It may be objected, that, when the petals and calyxes of flowers, and the leaves of fome vegetables, clofe in the night, this may be their natural ftate, like the clofing of the eyelids in the fleep of animals; and that it fhould thence be afcribed to the fufpenfion of volition, rather than to difagreeable fenfation. It may be anfwered, that in the fleep of animals the clofing of the eyelids may not be the natural ftate of the part, fince in the great inirritability and infenfibility attending fome fevers the patients fleep with their eyes half-open, and in actual death the eyes do not clofe fpontaneoufly, and that hence the clofing of the eyelids in fleep feems to be in confequence of our increafed internal fenfibility to light, or duft, or drynefs.

And it is certain, that the abfence of the accuftomed quantity of heat decreafes the action of animal fibres, as is evinced by the palenefs of the fkin, when it is expofed to great cold; and the increafed action of the fubcutaneous mufcles, as in fhuddering from cold, is certainly owing to the difagreeable fenfation confequent to the diminution of the accuftomed irritative motions, as in Sect. XXXII. 10. and Sect. IV. 5.

An excefs of moifture on fome parts of flowers and leaves may occafion a difagreeable fenfation, as when a drop of water gets down the windpipe into

into the lungs of animals, and may thus occafion them to clofe.

The approach of the anthers in many flowers to the ftigmas, and of the piftils of fome flowers to the anthers, muft be afcribed to the paffion of love, and hence belongs to fenfation, not to irritation.

III. That the vegetable world poffeffes fome degree of voluntary powers, appears from their neceffity to fleep, which we have fhewn in Sect. XVIII. to confift in the temporary abolition of voluntary power. This voluntary power feems to be exerted in the circular movement of the tendrils of vines, and other climbing vegetables; or in the efforts to turn the upper furface of their leaves, or their flowers to the light.

IV. The affociations of fibrous motions are obfervable in the vegetable world, as well as in the animal. The divifions of the leaves of the fenfitive plant have been accuftomed to contract at the fame time from the abfence of light; hence if by any other circumftance, as a flight ftroke or injury, one divifion is irritated into contraction, the neighbouring ones contract alfo, from their motions being affociated with thofe of the irritated part. So the various ftamina of the clafs of fyngenefia have been accuftomed to contract together in the evening, and thence if you ftimulate one of them with a pin, according to the experiment of M. Colvolo, they all contract from their acquired

acquired aſſociations.' Which alſo ſhews, that the number of male or female organs exiſting in one flower does not deſtroy the individuality of it; any more than the number of paps of a bitch or ſow, or the double organ of a barn-door cock; which is further evinced by the anthers and ſtigmas of ſome hermaphrodite flowers probably receiving their nutriment from the ſame honey-gland or nectary, and having their blood oxygenated by the ſame corol, while in the plants of the claſſes of monecia and diecia the male and female organs of reproduction belong to different vegetable beings.

To evince that the collapſing of the ſenſitive plant is not owing to any mechanical vibrations propagated along the whole branch, when a ſingle leaf is ſtruck with the finger, a leaf of it was ſlit with ſharp ſciſſars, and ſome ſeconds of time paſſed before the plant ſeemed ſenſible of the injury; and then the whole branch collapſed as far as the principal ſtem: this experiment was repeated ſeveral times with the leaſt poſſible impulſe to the plant.

V. 1. For the numerous circumſtances in which vegetable buds are analogous to animals, the reader is referred to the additional notes at the end of the Botanic Garden, Part I. It is there ſhewn, that the roots of vegetables reſemble the lacteal ſyſtem of animals; the ſap-veſſels in the early ſpring, before their leaves expand, are analogous

to

to the placental veſſels of the fœtus; that the leaves of land-plants reſemble lungs, and thoſe of aquatic plants the gills of fiſh; that there are other ſyſtems of veſſels reſembling the vena portarum of quadrupeds, or the aorta of fiſh; that the digeſtive power of vegetables is ſimilar to that of animals, converting the fluids, which they abſorb, into ſugar; that their ſeeds reſemble the eggs of animals, and their buds and bulbs their viviparous offspring. And, laſtly, that the anthers and ſtigmas are real animals, attached indeed to their parent tree like polypi or coral inſects, but capable of ſpontaneous motion; that they are affected with the paſſion of love, and furniſhed with powers of reproducing their ſpecies, and are fed with honey like the moths and butterflies, which plunder their nectaries. See Botanic Garden, Part I. add. note XXXIX.

The male flowers of valliſneria approach ſtill nearer to apparent animality, as they detach themſelves from the parent plant, and float on the ſurface of the water to the female ones. Botanic Garden, Part II. Art. Valliſneria. Other flowers of the claſſes of monecia and diecia, and polygamia, diſcharge the fecundating farina, which floating in the air is carried to the ſtigma of the female flowers, and that at conſiderable diſtances. Can this be effected by any ſpecific attraction? or, like the diffuſion of the odorous particles of flowers, is it left to the currents of

winds,

winds, and the accidental miscarriages of it counteracted by the quantity of its production?

2. This leads us to a curious inquiry, whether vegetables have ideas of external things? As all our ideas are originally received by our senses, the question may be changed to, whether vegetables possess any organs of sense? Certain it is, that they possess a sense of heat and cold, another of moisture and dryness, and another of light and darkness; for they close their petals occasionally from the presence of cold, moisture, or darkness. And it has been already shewn, that these actions cannot be performed simply from irritation, because cold and darkness are negative quantities, and on that account sensation or volition are implied, and in consequence a sensorium or union of their nerves. So when we go into the light, we contract the iris; not from any stimulus of the light on the fine muscles of the iris, but from its motions being associated with the sensation of too much light on the retina: which could not take place without a sensorium or centre of union of the nerves of the iris with those of vision. See Botanic Garden, Part I. Canto 3. l. 440. note.

Besides these organs of sense, which distinguish cold, moisture, and darkness, the leaves of mimosa, and of dionæa, and of drosera, and the stamens of many flowers, as of the berbery, and the numerous class of syngenesia, are sensible to mechanic impact, that is, they possess a sense of touch,

touch, as well as a common ſenſorium; by the medium of which their muſcles are excited into action. Laſtly, in many flowers the anthers, when mature, approach the ſtigma, in others the female organ approaches to the male. In a plant of collinſonia, a branch of which is now before me, the two yellow ſtamens are about three eights of an inch high, and diverge from each other at an angle of about fifteen degrees, the purple ſtyle is half an inch high, and in ſome flowers is now applied to the ſtamen on the right hand, and in others to that of the left; and will, I ſuppoſe, change place to-morrow in thoſe, where the anthers have not yet effuſed their powder.

I aſk, by what means are the anthers in many flowers, and ſtigmas in other flowers, directed to find their paramours? How do either of them know, that the other exiſts in their vicinity? Is this curious kind of ſtorge produced by mechanic attraction, or by the ſenſation of love? The latter opinion is ſupported by the ſtrongeſt analogy, becauſe a reproduction of the ſpecies is the conſequence; and then another organ of ſenſe muſt be wanted to direct theſe vegetable amourettes to find each other, one probably analogous to our ſenſe of ſmell, which in the animal world directs the new-born infant to its ſource of nouriſhment, and they may thus poſſeſs a faculty of perceiving as well as of producing odours.

Thus, beſides a kind of taſte at the extremities

ties of their roots, ſimilar to that of the extremities of our lacteal veſſels, for the purpoſe of ſelecting their proper food: and beſides different kinds of irritability reſiding in the various glands, which ſeparate honey, wax, reſin, and other juices from their blood; vegetable life ſeems to poſſeſs an organ of ſenſe to diſtinguiſh the variations of heat, another to diſtinguiſh the varying degrees of moiſture, another of light, another of touch, and probably another analogous to our ſenſe of ſmell. To theſe muſt be added the indubitable evidence of their paſſion of love, and I think we may truly conclude, that they are furniſhed with a common ſenſorium belonging to each bud, and that they muſt occaſionally repeat thoſe perceptions either in their dreams or waking hours, and conſequently poſſeſs ideas of ſo many of the properties of the external world, and of their own exiſtence.

## SECT. XIV.

### OF THE PRODUCTION OF IDEAS.

I. *Of material and immaterial beings. Doctrine of St. Paul.* II. 1. *Of the sense of touch. Of solidity.* 2. *Of figure. Motion. Time. Place. Space. Number.* 3. *Of the penetrability of matter.* 4. *Spirit of animation possesses solidity, figure, visibility, &c. Of spirits and angels.* 5. *The existence of external things.* III. *Of vision.* IV. *Of hearing.* V. *Of smell and taste.* VI. *Of the organ of sense by which we perceive heat and cold, not by the sense of touch.* VII *Of the sense of extension, the whole of the locomotive muscles may be considered as one organ of sense.* VIII. *Of the senses of hunger, thirst, want of fresh air, suckling children, and lust.* IX. *Of many other organs of sense belonging to the glands. Of painful sensations from the excess of light, pressure, heat, itching, caustics, and electricity.*

I. PHILOSOPHERS have been much perplexed to understand, in what manner we become acquainted with the external world; insomuch that Dr. Berkeley even doubted its existence, from having observed (as he thought) that none of our ideas resemble their correspondent objects. Mr. Hume asserts, that our belief depends on the greater distinctness or energy of our ideas from perception;

perception; and Mr. Reid has lately contended, that our belief of external objects is an innate principle neceſſarily joined with our perceptions.

So true is the obſervation of the famous Malbranch, "that our ſenſes are not given us to diſcover the eſſences of things, but to acquaint us with the means of preſerving our exiſtence," (L. I. ch. v.) a melancholy reflection to philoſophers!

Some philoſophers have divided all created beings into material and immaterial: the former including all that part of being, which obeys the mechanic laws of action and reaction, but which can begin no motion of itſelf; the other is the cauſe of all motion, and is either termed the power of gravity, or of ſpecific attraction, or the ſpirit of animation. This immaterial agent is ſuppoſed to exiſt in or with matter, but to be quite diſtinct from it, and to be equally capable of exiſtence, after the matter, which now poſſeſſes it, is decompoſed.

Nor is this theory ill ſupported by analogy, ſince heat, electricity, and magnetiſm, can be given to or taken from a piece of iron; and muſt therefore exiſt, whether ſeparated from the metal, or combined with it. From a parity of reaſoning, the ſpirit of animation would appear to be capable of exiſting as well ſeparately from the body as with it.

I beg to be underſtood, that I do not wiſh to diſpute about words, and am ready to allow, that

the powers of gravity, ſpecific attraction, electricity, magnetiſm, and even the ſpirit of animation, may conſiſt of matter of a finer kind; and to believe, with St. Paul and Malbranch, that the ultimate cauſe only of all motion is immaterial, that is God. St. Paul ſays, "in him we live and move, and have our being;" and, in the 15th chapter to the Corinthians, diſtinguiſhes between the pſyche or living ſpirit, and the pneuma or reviving ſpirit. By the words ſpirit of animation or ſenſorial power, I mean only that animal life, which mankind poſſeſſes in common with brutes, and in ſome degree even with vegetables, and leave the conſideration of the immortal part of us, which is the object of religion, to thoſe who treat of revelation.

### II. 1. *Of the Senſe of Touch.*

THE firſt ideas we become acquainted with, are thoſe of the ſenſe of touch; for the fœtus muſt experience ſome varieties of agitation, and exert ſome muſcular action, in the womb; and may with great probability be ſuppoſed thus to gain ſome ideas of its own figure, of that of the uterus, and of the tenacity of the fluid, that ſurrounds it, (as appears from the facts mentioned in the ſucceeding Section upon Inſtinct.)

Many of the organs of ſenſe are confined to a ſmall part of the body, as the noſtrils, ear, or

eye,

eye, whilſt the ſenſe of touch is diffuſed over the whole ſkin, but exiſts with a more exquiſite degree of delicacy at the extremities of the fingers and thumbs, and in the lips. The ſenſe of touch is thus very commodiouſly diſpoſed for the purpoſe of encompaſſing ſmaller bodies, and for adapting itſelf to the inequalities of larger ones. The figure of ſmall bodies ſeems to be learnt by children by their lips as much as by their fingers; on which account they put every new object to their mouths, when they are ſatiated with food, as well as when they are hungry. And puppies ſeem to learn their ideas of figure principally by the lips in their mode of play.

We acquire our tangible ideas of objects either by the ſimple preſſure of this organ of touch againſt a ſolid body, or by moving our organ of touch along the ſurface of it. In the former caſe we learn the length and breadth of the object by the quantity of our organ of touch, that is impreſſed by it: in the latter caſe we learn the length and breadth of objects by the continuance of their preſſure on our moving organ of touch.

It is hence, that we are very ſlow in acquiring our tangible ideas, and very ſlow in recollecting them; for if I now think of the tangible idea of a cube, that is, if I think of its figure, and of the ſolidity of every part of that figure, I muſt conceive myſelf as paſſing my fingers over it, and ſeem in ſome meaſure to feel the idea, as I for-

merly did the impreffion, at the ends of them, and am thus very flow in diftinctly recollecting it.

When a body compreffes any part of our fenfe of touch, what happens? Firft, this part of our fenforium undergoes a mechanical compreffion, which is termed a ftimulus; fecondly, an idea, or contraction of a part of the organ of fenfe is excited; thirdly, a motion of the central parts, or of the whole fenforium, which is termed fenfation, is produced; and thefe three conftitute the perception of folidity.

2. *Of Figure, Motion, Time, Place, Space, Number.*

No one will deny, that the medulla of the brain and nerves has a certain figure; which, as it is diffufed through nearly the whole of the body, muft have nearly the figure of that body. Now it follows, that the fpirit of animation, or living principle, as it occupies this medulla, and no other part, (which is evinced by a great variety of cruel experiments on living animals,) it follows, that this fpirit of animation has alfo the fame figure as the medulla above defcribed. I appeal to common fenfe! the fpirit of animation acts, Where does it act? It acts wherever there is the medulla above mentioned; and that whether the limb is yet joined to a living animal, or whether it be recently detached from it; as the heart of a viper

viper or frog will renew its contractions, when pricked with a pin, for many minutes of time after its exsection from the body.—Does it act any where else?—No; then it certainly exists in this part of space, and no where else; that is, it hath figure; namely, the figure of the nervous system, which is nearly the figure of the body. When the idea of solidity is excited, as above explained, a part of the extensive organ of touch is compressed by some external body, and this part of the sensorium so compressed exactly resembles *in figure* the figure of the body that compressed it. Hence, when we acquire the idea of solidity, we acquire at the same time the idea of FIGURE; and this idea of figure, or motion of *a part* of the organ of touch, exactly resembles *in its figure* the figure of the body that occasions it; and thus exactly acquaints us with this property of the external world.

Now, as the whole universe with all its parts possesses a certain form or figure, if any part of it moves, that form or figure of the whole is varied: hence, as MOTION is no other than a perpetual variation of figure, our idea of motion is also a real resemblance of the motion that produced it.

It may be said in objection to this definition of motion, that an ivory globe may revolve on its axis, and that here will be a motion without change of figure. But the figure of the particle

*x* on one ſide of this globe is not the *ſame* figure as the figure of *y* on the other ſide, any more than the particles themſelves are the ſame, though they are *ſimilar* figures; and hence they cannot change place with each other without diſturbing or changing the figure of the whole.

Our idea of TIME is from the ſame ſource, but is more abſtracted, as it includes only the comparative velocities of theſe variations of figure; hence if it be aſked, How long was this book in printing? it may be anſwered, Whilſt the ſun was paſſing through Aries.

Our idea of PLACE includes only the figure of a group of bodies, not the figures of the bodies themſelves. If it be aſked where is Nottinghamſhire, the anſwer is, it is ſurrounded by Derbyſhire, Lincolnſhire, and Leiceſterſhire; hence place is our idea of the figure of one body ſurrounded by the figures of other bodies.

The idea of SPACE is a more abſtracted idea of place excluding the group of bodies.

The idea of NUMBER includes only the particular arrangements, or diſtributions of a group of bodies, and is therefore only a more abſtracted idea of the parts of the figure of the group of bodies; thus when I ſay England is divided into forty counties, I only ſpeak of certain diviſions of its figure.

Hence ariſes the certainty of the mathematical ſciences, as they explain theſe properties of bodies,

dies, which are exactly refembled by our ideas of them, whilft we are obliged to collect almoft all our other knowledge from experiment; that is, by obferving the effects exerted by one body upon another.

### 3. *Of the Penetrability of Matter.*

The impoffibility of two bodies exifting together in the fame fpace cannot be deduced from our idea of folidity, or of figure. As foon as we perceive the motions of objects that furround us, and learn that we poffefs a power to move our own bodies, we experience, that thofe objects, which excite in us the idea of folidity and of figure, oppofe this voluntary movement of our own organs; as whilft I endeavour to comprefs between my hands an ivory ball into a fpheroid. And we are hence taught by experience, that our own body and thofe, which we touch, cannot exift in the fame part of fpace.

But this by no means demonftrates, that no two bodies can exift together in the fame part of fpace. Galilæo in the preface to his works feems to be of opinion, that matter is not impenetrable; Mr. Mitchel, and Mr. Bofcowich in his Theoria Philof. Natur. have efpoufed this hypothefis: which has been lately publifhed by Dr. Prieftley, to whom the world is much indebted for fo many important difcoveries in fcience. (Hift. of Light and

and Colours, p. 391.) The uninterrupted paſ-ſage of light through tranſparent bodies, of the electric æther through metallic and aqueous bo-dies, and of the magnetic effluvia through all bodies, would ſeem to give ſome probability to this opinion. Hence it appears, that beings may exiſt without poſſeſſing the property of ſolidity, as well as they can exiſt without poſſeſſing the properties, which excite our ſmell or taſte, and can thence occupy ſpace without detruding other bodies from it; but we cannot become acquaint-ed with ſuch beings by our ſenſe of touch, any more than we can with odours or flavours without our ſenſes of ſmell and taſte.

But that any being can exiſt without exiſting in ſpace, is to my ideas utterly incomprehenſible. My appeal is to common ſenſe. *To be* implies a when and a where; the one is comparing it with the motions of other beings, and the other with their ſituations.

If there was but one object, as the whole crea-tion may be conſidered as one object, then I can-not aſk where it exiſts? for there are no other objects to compare its ſituation with. Hence if any one denies, that a being exiſts in ſpace, he denies, that there are any other beings but that one; for to anſwer the queſtion, "Where does it exiſt?" is only to mention the ſituation of the objects that ſurround it.

In the ſame manner if it be aſked—"When

does

does a being exift?" The anfwer only fpecifies the fucceffive motions either of itfelf, or of other bodies; hence to fay, a body exifts not in time, is to fay, that there is, or was, no motion in the world.

### 4. *Of the Spirit of Animation.*

But though there may exift beings in the univerfe, that have not the property of folidity; that is, which can poffefs any part of fpace, at the fame time that it is occupied by other bodies; yet there may be other beings, that can affume this property of folidity, or difrobe themfelves of it occafionally, as we are taught of fpirits, and of angels; and it would feem, that THE SPIRIT OF ANIMATION muft be endued with this property, otherwife how could it occafionally give motion to the limbs of animals?—or be itfelf ftimulated into motion by the obtrufions of furrounding bodies, as of light, or odour?

If the fpirit of animation was always neceffarily penetrable, it could not influence or be influenced by the folidity of common matter; they would exift together, but could not detrude each other from the part of fpace, where they exift; that is, they could not communicate motion to each other. *No two things can influence or affect each other, which have not fome property common to both of them*; for to influence or affect another body is

is to give or communicate ſome property to it, that it had not before; but how can one body give that to another, which it does not poſſeſs itſelf?—The words imply, that they muſt agree in having the power or faculty of poſſeſſing ſome common property. Thus if one body removes another from the part of ſpace, that it poſſeſſes, it muſt have the power of occupying that ſpace itſelf: and if one body communicates heat or motion to another, it follows, that they have alike the property of poſſeſſing heat or motion.

Hence the ſpirit of animation, at the time it communicates or receives motion from ſolid bodies, muſt itſelf poſſeſs ſome property of ſolidity. And in conſequence at the time it receives other kinds of motion from light, it muſt poſſeſs that property, which light poſſeſſes, to communicate that kind of motion; and for which no language has a name, unleſs it may be termed Viſibility. And at the time it is ſtimulated into other kinds of animal motion by the particles of ſapid and odorous bodies affecting the ſenſes of taſte and ſmell, it muſt reſemble theſe particles of flavour, and of odour, in poſſeſſing ſome ſimilar or correſpondent property; and for which language has no name, unleſs we may uſe the words Saporoſity and Odoroſity for thoſe common properties, which are poſſeſſed by our organs of taſte and ſmell, and by the particles of ſapid and odorous bodies; as the words Tangibility and

and Audibility may exprefs the common property poffeffed by our organs of touch, and of hearing, and by the folid bodies, or their vibrations, which affect thofe organs.

5. Finally, though the figures of bodies are in truth refembled by the figure of the part of the organ of touch, which is ftimulated into motion; and that organ refembles the folid body, which ftimulates it, in its property of folidity; and though the fenfe of hearing refembles the vibrations of external bodies in its capability of being ftimulated into motion by thofe vibrations; and though our other organs of fenfe refemble the bodies, that ftimulate them, in their capability of being ftimulated by them; and we hence become acquainted with thefe properties of the external world; yet as we can repeat all thefe motions of our organs of fenfe by the efforts of volition, or in confequence of the fenfation of pleafure or pain, or by their affociation with other fibrous motions, as happens in our reveries or in fleep, there would ftill appear to be fome difficulty in demonftrating the exiftence of any thing external to us.

In our dreams we cannot determine this circumftance, becaufe our power of volition is fufpended, and the ftimuli of external objects are excluded; but in our waking hours we can compare our ideas belonging to one fenfe with thofe belonging to another, and can thus diftinguifh the

the ideas occaſioned by irritation from thoſe excited by ſenſation, volition, or aſſociation. Thus if the idea of the ſweetneſs of ſugar ſhould be excited in our dreams, the whiteneſs and hardneſs of it occur at the ſame time by aſſociation; and we believe a material lump of ſugar preſent before us. But if, in our waking hours, the idea of the ſweetneſs of ſugar occurs to us, the ſtimuli of ſurrounding objects, as the edge of the table, on which we preſs, or green colour of the graſs, on which we tread, prevent the other ideas of the hardneſs and whiteneſs of the ſugar from being excited by aſſociation. Or if they ſhould occur, we voluntarily compare them with the irritative ideas of the table or graſs above mentioned, and detect their fallacy. We can thus diſtinguiſh the ideas cauſed by the ſtimuli of external objects from thoſe, which are introduced by aſſociation, ſenſation, or volition; and during our waking hours can thus acquire a knowledge of the external world. Which nevertheleſs we cannot do in our dreams, becauſe we have neither perceptions of external bodies, nor the power of volition to enable us to compare them with the ideas of imagination.

### III. *Of Viſion.*

OUR eyes obſerve a difference of colour, or of ſhade, in the prominences and depreſſions of ob-

jects, and that thofe fhades uniformly vary, when the fenfe of touch obferves any variation. Hence when the retina becomes ftimulated by colours or fhades of light in a certain form, as in a circular fpot; we know by experience, that this is a fign, that a tangible body is before us; and that its figure is refembled by the miniature figure of the part of the organ of vifion, that is thus ftimulated.

Here whilft the ftimulated part of the retina refembles exactly the vifible figure of the whole in miniature, the various kinds of ftimuli from different colours mark the vifible figures of the minuter parts; and by habit we inftantly recall the tangible figures.

Thus when a tree is the object of fight, a part of the retina refembling a flat branching figure is ftimulated by various fhades of colours; but it is by fuggeftion, that the gibbofity of the tree, and the mofs, that fringes its trunk, appear before us. Thefe are ideas of fuggeftion, which we feel or attend to, affociated with the motions of the retina, or irritative ideas, which we do not attend to.

So that though our vifible ideas refemble in miniature the outline of the figure of coloured bodies, in other refpects they ferve only as a language, which by acquired affociations introduce the tangible ideas of bodies. Hence it is, that this fenfe is fo readily deceived by the art of the painter to our amufement and inftruction.

The reader will find much very curious knowledge on this ſubject in Biſhop Berkeley's Eſſay on Viſion, a work of great ingenuity.

The immediate object however of the ſenſe of viſion is light; this fluid, though its velocity is ſo great, appears to have no perceptible mechanical impulſe, as was mentioned in the third Section, but ſeems to ſtimulate the retina into animal motion by its tranſmiſſion through this part of the ſenſorium: for though the eyes of cats or other animals appear luminous in obſcure places; yet it is probable, that none of the light, which falls on the retina, is reflected from it, but adheres to or enters into combination with the choroide coat behind it.

The combination of the particles of light with opake bodies, and therefore with the choroide coat of the eye, is evinced from the heat which is given out, as in other chemical combinations. For the ſun-beams communicate no heat in their paſſage through tranſparent bodies, with which they do not combine, as the air continues cool even in the focus of the largeſt burning-glaſſes, which in a moment vitrifies a particle of opaque matter.

### IV. *Of the Organ of Hearing.*

IT is generally believed, that the tympanum of the ear vibrates mechanically, when expoſed

to audible ſounds, like the ſtrings of one muſical inſtrument, when the ſame notes are ſtruck upon another. Nor is thi opinion improbable, as the muſcles and cartilages of the larynx are employed in producing variety of tones by mechanical vibration: ſo the muſcles and bones of the ear ſeem adapted to increaſe or diminiſh the tenſion of the tympanum for the purpoſes of ſimilar mechanical vibrations.

But it appears from diſſection, that the tympanum is not the immediate organ of hearing, but that, like the humours and cornea of the eye, it is only of uſe to prepare the object for the immediate organ. For the portio mollis of the auditory nerve is not ſpread upon the tympanum, but upon the veſtibulum, and cochlea, and ſemicircular canals of the ear; while between the tympanum and the expanſion of the auditory nerve the cavity is ſaid by Dr. Cotunnus and Dr. Meckel to be filled with water; as they had frequently obſerved by freezing the heads of dead animals before they diſſected them; and water being a more denſe fluid than air is much better adapted to the propagation of vibrations. We may add, that even the external opening of the ear is not abſolutely neceſſary for the perception of ſound: for ſome people, who from theſe defects would have been completely deaf, have diſtinguiſhed acute or grave ſounds by the tremours of a ſtick held between their teeth propagated along

the bones of the head, (Haller. Phyf. T. V. p. 295).

Hence it appears, that the immediate organ of hearing is not affected by the particles of the air themfelves, but is ftimulated into animal motion by the vibrations of them. And it is probable from the loofe bones, which are found in the heads of fome fifhes, that the vibrations of water are fenfible to the inhabitants of that element by a fimilar organ.

The motions of the atmofphere, which we become acquainted with by the fenfe of touch, are combined with its folidity, weight, or vis inertiæ; whereas thofe, that are perceived by this organ, depend alone on its elafticity. But though the vibration of the air is the immediate object of the fenfe of hearing, yet the ideas, we receive by this fenfe, like thofe received from light, are only as a language, which by acquired affociations acquaints us with thofe motions of tangible bodies, which depend on their elafticity; and which we had before learned by our fenfe of touch.

### V. *Of Smell and of Tafte.*

The objects of fmell are diffolved in the fluid atmofphere, and thofe of tafte in the faliva, or other aqueous fluid, for the better diffufing them on their refpective organs, which feem to be ftimulated into animal motion perhaps by the chemical

mical affinities of these particles, which constitute the sapidity and odorosity of bodies, with the nerves of sense, which perceive them.

Mr. Volta has lately observed a curious circumstance relative to our sense of taste. If a bit of clean lead and a bit of clean silver be separately applied to the tongue and palate no taste is perceived; but by applying them in contact in respect to the parts out of the mouth, and nearly so in respect to the parts, which are immediately applied to the tongue and palate, a saline or acidulous taste is perceived, as of a fluid like a stream of electricity passing from one of them to the other. This new application of the sense of taste deserves further investigation, as it may acquaint us with new properties of matter.

From the experiments above mentioned of Galvani, Volta, Fowler, and others, it appears, that a plate of zinc and a plate of silver have greater effect than lead and silver. If one edge of a plate of silver about the size of half a crown-piece be placed upon the tongue, and one edge of a plate of zinc about the same size beneath the tongue, and if their opposite edges are then brought into contact before the point of the tongue, a taste is perceived at the moment of their coming into contact; secondly, if one of the above plates be put between the upper lip and the gum of the fore-teeth, and the other be placed under the tongue, and their exterior edges

be then brought into contact in a darkifh room, a flafh of light is perceived in the eyes.

Thefe effects I imagine only fhew the fenfibility of our nerves of fenfe to very fmall quantities of the electric fluid, as it paffes through them; for I fuppofe thefe fenfations are occafioned by flight electric fhocks produced in the following manner. By the experiments publifhed by Mr. Bennet, with his ingenious doubler of electricity, which is the greateft difcovery made in that fcience fince the coated jar, and the eduction of lightning from the fkies, it appears that zinc was always found minus, and filver was always found plus, when both of them were in their feparate ftate. Hence, when they are placed in the manner above defcribed, as foon as their exterior edges come nearly into contact, fo near as to have an extremely thin plate of air between them, that plate of air becomes charged in the fame manner as a plate of coated glafs; and is at the fame inftant difcharged through the nerves of tafte or of fight, and gives the fenfations, as above defcribed, of light or of faporofity; and only fhews the great fenfibility of thefe organs of fenfe to the ftimulus of the electric fluid in fuddenly paffing through them.

### VI. *Of the Senfe of Heat.*

There are many experiments in chemical writers, that evince the exiftence of heat as a fluid element,

element, which covers and pervades all bodies, and is attracted by the folutions of fome of them, and is detruded from the combination of others. Thus from the combinations of metals with acids, and from thofe combinations of animal fluids, which are termed fecretions, this fluid matter of heat is given out amongft the neighbouring bodies; and in the folutions of falts in water, or of water in air, it is abforbed from the bodies, that furround them; whilft in its facility in paffing through metallic bodies, and its difficulty in pervading refins and glafs, it refembles the properties of the electric aura; and is like that excited by friction, and feems like that to gravitate amongft other bodies in its uncombined ftate, and to find its equilibrium.

There is no circumftance of more confequence in the animal economy than a due proportion of this fluid of heat; for the digeftion of our nutriment in the ftomach and bowels, and the proper qualities of all our fecreted fluids, as they are produced or prepared partly by animal and partly by chemical proceffes, depend much on the quantity of heat; the excefs of which, or its deficiency, alike gives us pain, and induces us to avoid the circumftances that occafion them. And in this the perception of heat effentially differs from the perceptions of the fenfe of touch, as we receive pain from too great preffure of folid bodies, but none from the abfence of it. It is

hence probable, that nature has provided us with a ſet of nerves for the perception of this fluid, which anatomiſts have not yet attended to.

There may be ſome difficulty in the proof of this aſſertion; if we look at a hot fire, we experience no pain of the optic nerve, though the heat along with the light muſt be concentrated upon it. Nor does warm water or warm oil poured into the ear give pain to the organ of hearing; and hence as theſe organs of ſenſe do not perceive ſmall exceſſes or deficiencies of heat; and as heat has no greater analogy to the ſolidity or to the figures of bodies, than it has to their colours or vibrations; there ſeems no ſufficient reaſon for our aſcribing the perception of heat and cold to the ſenſe of touch; to which it has generally been attributed, either becauſe it is diffuſed beneath the whole ſkin like the ſenſe of touch, or owing to the inaccuracy of our obſervations, or the defect of our languages.

There is another circumſtance would induce us to believe, that the perceptions of heat and cold do not belong to the organ of touch; ſince the teeth, which are the leaſt adapted for the perceptions of ſolidity of figure, are the moſt ſenſible to heat or cold; whence we are forewarned from ſwallowing thoſe materials, whoſe degree of coldneſs or of heat would injure our ſtomachs.

The following is an extract from a letter of Dr. R. W. Darwin, of Shrewſbury, when he was

a ſtudent at Edinburgh. "I made an experiment yeſterday in our hoſpital, which much favours your opinion, that the ſenſation of heat and of touch depend on different ſets of nerves. A man who had lately recovered from a fever, and was ſtill weak, was ſeized with violent cramps in his legs and feet; which were removed by opiates, except that one of his feet remained inſenſible. Mr. Ewart pricked him with a pin in five or ſix places, and the patient declared he did not feel it in the leaſt, nor was he ſenſible of a very ſmart pinch. I then held a red-hot poker at ſome diſtance; and brought it gradually nearer till it came within three inches, when he aſſerted that he felt it quite diſtinctly. I ſuppoſe ſome violent irritation on the nerves of touch had cauſed the cramps, and had left them paralytic; while the nerves of heat, having ſuffered no increaſed ſtimulus, retained their irritability."

Add to this, that the lungs, though eaſily ſtimulated into inflammation, are not ſenſible to heat. See Claſs III. 1. 1. 10.

## VII. *Of the Senſe of Extenſion.*

The organ of touch is properly the ſenſe of preſſure, but the muſcular fibres themſelves conſtitute the organ of ſenſe, that feels extenſion. The ſenſe of preſſure is always attended with the ideas of the figure and ſolidity of the object,

 neither

neither of which accompany our perception of extenſion. The whole ſet of muſcles, whether they are hollow ones, as the heart, arteries, and inteſtines, or longitudinal ones attached to bones, contract themſelves, whenever they are ſtimulated by forcible elongation; and it is obſervable, that the white muſcles, which conſtitute the arterial ſyſtem, ſeem to be excited into contraction from no other kinds of ſtimulus, according to the experiments of Haller. And hence the violent pain in ſome inflammations, as in the paronychia, obtains immediate relief by cutting the membrane, that was ſtretched by the tumour of the ſubjacent parts.

Hence the whole muſcular ſyſtem may be conſidered as one organ of ſenſe, and the various attitudes of the body, as ideas belonging to this organ, of many of which we are hourly conſcious, while many others, like the irritative ideas of the other ſenſes, are performed without our attention.

When the muſcles of the heart ceaſe to act, the refluent blood again diſtends or elongates them; and thus irritated they contract as before. The ſame happens to the arterial ſyſtem, and I ſuppoſe to the capillaries, inteſtines, and various glands of the body.

When the quantity of urine, or of excrement, diſtends the bladder, or rectum, thoſe parts contract, and exclude their contents, and many other muſcles by aſſociation act along with them; but if theſe evacuations are not ſoon complied with,

pain

pain is produced by a little further extenſion of the muſcular fibres: a ſimilar pain is cauſed in the muſcles, when a limb is much extended for the reduction of diſlocated bones; and in the puniſhment of the rack: and in the painful cramps of the calf of the leg, or of other muſcles, for a greater degree of contraction of a muſcle, than the movement of the two bones, to which its ends are affixed, will admit of, muſt give ſimilar pain to that, which is produced by extending it beyond its due length. And the pain from punctures or inciſions ariſes from the diſtention of the fibres, as the knife paſſes through them; for it nearly ceaſes as ſoon as the diviſion is completed.

All theſe motions of the muſcles, that are thus naturally excited by the ſtimulus of diſtending bodies, are alſo liable to be called into ſtrong action by their catenation with the irritations or ſenſations produced by the momentum of the progreſſive particles of blood in the arteries, as in inflammatory fevers, or by acrid ſubſtances on other ſenſible organs, as in the ſtrangury, or teneſmus, or cholera.

We ſhall conclude this account of the ſenſe of extenſion by obſerving, that the want of its object is attended with a diſagreeable ſenſation, as well as the exceſs of it. In thoſe hollow muſcles, which have been accuſtomed to it, this diſagreeable ſenſation is called faintneſs, emptineſs, and ſinking;

ſinking; and, when it ariſes to a certain degree, is attended with ſyncope, or a total quieſcence of all motions, but the internal irritative ones, as happens from ſudden loſs of blood, or in the operation of tapping in the dropſy.

VIII. *Of the Appetites of Hunger, Thirſt, Heat, Extenſion, the want of Freſh Air, animal Love, and the Suckling of Children.*

Hunger is moſt probably perceived by thoſe numerous ramifications of nerves that are ſeen about the upper opening of the ſtomach; and thirſt by the nerves about the fauces, and the top of the gula. The ideas of theſe ſenſes are few in the generality of mankind, but are more numerous in thoſe, who by diſeaſe, or indulgence, deſire particular kinds of foods or liquids.

A ſenſe of heat has already been ſpoken of, which may with propriety be called an appetite, as we painfully deſire it, when it is deficient in quantity.

The ſenſe of extenſion may be ranked amongſt theſe appetites, ſince the deficiency of its object gives diſagreeable ſenſation; when this happens in the arterial ſyſtem, it is called faintneſs, and ſeems to bear ſome analogy to hunger and to cold; which like it are attended with emptineſs of a part of the vaſcular ſyſtem.

The ſenſe of want of freſh air has not been attended

attended to, but is as diftinct as the others, and the firft perhaps that we experience after our nativity; from the want of the object of this fenfe many difeafes are produced, as the jail-fever, plague, and other epidemic maladies. Animal love is another appetite, which occurs later in life, and the females of lactiferous animals have another natural inlet of pleafure or pain from the fuckling their offspring. The want of which, either owing to the death of their progeny, or to the fafhion of their country, has been fatal to many of the fex. The males have alfo pectoral glands, which are frequently turgid with a thin milk at their nativity, and are furnifhed with nipples, which erect on titillation like thofe of the female; but which feem now to be of no further ufe, owing perhaps to fome change which thefe animals have undergone in the gradual progreffion of the formation of the earth, and of all that it inhabit.

Thefe feven laft mentioned fenfes may properly be termed appetites, as they differ from thofe of touch, fight, hearing, tafte, and fmell, in this refpect; that they are affected with pain as well by the defect of their objects as by the excefs of them, which is not fo in the latter. Thus cold and hunger give us pain, as well as an excefs of heat or fatiety; but it is not fo with darknefs and filence.

IX. Before

IX. Before we conclude this Section on the organs of ſenſe, we muſt obſerve, that, as far as we know, there are many more ſenſes than have been here mentioned, as every gland ſeems to be influenced to ſeparate from the blood, or to abſorb from the cavities of the body, or from the atmoſphere, its appropriated fluid, by the ſtimulus of that fluid on the living gland; and not by mechanical capillary abſorption, nor by chemical affinity. Hence it appears, that each of theſe glands muſt have a peculiar organ to perceive theſe irritations, but as theſe irritations are not ſucceeded by ſenſation, they have not acquired the names of ſenſes.

However when theſe glands are excited into motions ſtronger than uſual, either by the acrimony of their fluids, or by their own irritability being much increaſed, then the ſenſation of pain is produced in them as in all the other ſenſes of the body; and theſe pains are all of different kinds, and hence the glands at this time really become each a different organ of ſenſe, though theſe different kinds of pain have acquired no names.

Thus a great exceſs of light does not give the idea of light but of pain; as in forcibly opening the eye when it is much inflamed. The great exceſs of preſſure or diſtention, as when the point of a pin is preſſed upon our ſkin, produces pain, (and when this pain of the ſenſe of diſtention

is ſlighter, it is termed itching, or tickling), without any idea of ſolidity or of figure: an exceſs of heat produces ſmarting, of cold another kind of pain; it is probable by this ſenſe of heat the pain produced by cauſtic bodies is perceived, and of electricity, as all theſe are fluids, that permeate, diſtend, or decompoſe the parts that feel them.

## SECT. XV.

### OF THE CLASSES OF IDEAS.

I. 1. *Ideas received in tribes.* 2. *We combine them further, or abſtract from theſe tribes.* 3. *Complex ideas.* 4. *Compounded ideas.* 5. *Simple ideas, modes, ſubſtances, relations, general ideas.* 6. *Ideas of reflexion.* 7. *Memory and imagination imperfectly defined. Ideal preſence. Memorandum-rings.* II. 1. *Irritative ideas. Perception.* 2. *Senſitive ideas, imagination.* 3. *Voluntary ideas, recollection.* 4. *Aſſociated ideas, ſuggeſtion.* III. 1. *Definitions of perception, memory.* 2. *Reaſoning, judgment, doubting, diſtinguiſhing, comparing.* 3. *Invention.* 4. *Conſciouſneſs.* 5. *Identity.* 6. *Lapſe of time.* 7. *Freewill.*

I. 1. As the conſtituent elements of the material world are only perceptible to our organs of ſenſe in a ſtate of combination; it follows, that the ideas or ſenſual motions excited by them, are never received ſingly, but ever with a greater or leſs degree of combination. So the colours of bodies or their hardneſſes occur with their figures: every ſmell and taſte has its degree of pungency as well as its peculiar flavour: and each note in muſic is combined with the tone of ſome inſtrument. It appears from hence, that we can be ſenſible of a number of ideas at the ſame time, ſuch

ſuch as the whiteneſs, hardneſs, and coldneſs of a ſnow-ball, and can experience at the ſame time many irritative ideas of ſurrounding bodies, which we do not attend to, as mentioned in Section VII. 3. 2. But thoſe ideas which belong to the ſame ſenſe, ſeem to be more eaſily combined into ſynchronous tribes, than thoſe which were not received by the ſame ſenſe, as we can more eaſily think of the whiteneſs and figure of a lump of ſugar at the ſame time, than the whiteneſs and ſweetneſs of it.

2. As theſe ideas, or ſenſual motions, are thus excited with greater or leſs degrees of combination; ſo we have a power, when we repeat them either by our volition or ſenſation, to increaſe or diminiſh this degree of combination, that is, to form compounded ideas from thoſe, which were more ſimple; and abſtract ones from thoſe, which were more complex, when they were firſt excited; that is, we can repeat a part or the whole of thoſe ſenſual motions, which did conſtitute our ideas of perception; and the repetition of which now conſtitutes our ideas of recollection, or of imagination.

3. Thoſe ideas, which we repeat without change of the quantity of that combination, with which we firſt received them, are called complex ideas, as when you recollect Weſtminſter Abbey, or the planet Saturn: but it muſt be obſerved, that theſe complex ideas, thus re-excited by volition, ſen-

ſation, or aſſociation, are ſeldom perfect copies of their correſpondent perceptions, except in our dreams, where other external objects do not detract our attention.

4. Thoſe ideas, which are more complex than the natural objects that firſt excited them, have been called compounded ideas, as when we think of a ſphinx, or griffin.

5. And thoſe that are leſs complex than the correſpondent natural objects, have been termed abſtracted ideas: thus ſweetneſs, and whiteneſs, and ſolidity, are received at the ſame time from a lump of ſugar, yet I can recollect any of theſe qualities without thinking of the others, that were excited along with them. See Sect. XVI. 17.

When ideas are ſo far abſtracted as in the above example, they have been termed ſimple by the writers of metaphyſics, and ſeem indeed to be more complete repetitions of the ideas or ſenſual motions, originally excited by external objects.

Other claſſes of theſe ideas, where the abſtraction has not been ſo great, have been termed, by Mr. Locke, modes, ſubſtances, and relations, but they ſeem only to differ in their degree of abſtraction from the complex ideas that were at firſt excited; for as theſe complex or natural ideas are themſelves imperfect copies of their correſpondent perceptions, ſo theſe abſtract or general ideas are only ſtill more imperfect copies of the

ſame

fame perceptions. Thus when I have feen an object but once, as a rhinoceros, my abftract idea of this animal is the fame as my complex one. I may think more or lefs diftinctly of a rhinoceros, but it is the very rhinoceros that I faw, or fome part or property of him, which recurs to my mind.

But when any clafs of complex objects becomes the fubject of converfation, of which I have feen many individuals, as a caftle or an army, fome property or circumftance belonging to it is peculiarly alluded to; and then I feel in my own mind, that my abftract idea of this complex object is only an idea of that part, property, or attitude of it, that employs the prefent converfation, and varies with every fentence that is fpoken concerning it. So if any one fhould fay, "one may fit upon a horfe fafer than on a camel," my abftract idea of the two animals includes only an outline of the level back of the one, and the gibbofity on the back of the other. What noife is that in the ftreet?—Some horfes trotting over the pavement. Here my idea of the horfes includes principally the fhape and motion of their legs. So alfo the abftract ideas of goodnefs and courage are ftill more imperfect reprefentations of the objects they were received from; for here we abftract the material parts, and recollect only the qualities.

Thus we abftract fo much from fome of our complex ideas, that at length it becomes difficult

to determine of what perception they partake; and in many inſtances our idea ſeems to be no other than of the ſound or letters of the word, that ſtands for the collective tribe, of which we are ſaid to have an abſtracted idea, as noun, verb, chimæra, apparition.

Mr. Horne Tooke alſo, in his Diverſions of Purley, has very ingeniouſly ſhewn, that what were called general ideas, are in reality only general terms; or words which ſignify any parts of a complex object. Whence ariſes much error in our verbal reaſoning, as the ſame word has different ſignifications. And hence thoſe, who can think without words, reaſon more accurately than thoſe, who only compare the ideas ſuggeſted by words; a rare faculty, which diſtinguiſhes the writers of philoſophy from thoſe of ſophiſtry. See Claſs III. 2. 2. 3.

6. Ideas have been divided into thoſe of perception and thoſe of reflection, but as whatever is perceived muſt be external to the organ that perceives it, all our ideas muſt originally be ideas of perception.

7. Others have divided our ideas into thoſe of memory, and thoſe of imagination; they have ſaid that a recollection of ideas in the order they were received conſtitutes memory, and without that order imagination; but all the ideas of imagination, excepting the few that are termed ſimple ideas, are parts of trains

or

or tribes in the order they were received; as if I think of a fphinx, or a griffin, the fair face, bofom, wings, claws, tail, are all complex ideas in the order they were received: and it behoves the writers, who adhere to this definition, to determine, how fmall the trains muft be, that fhall be called imagination; and how great thofe, that fhall be called memory.

Others have thought that the ideas of memory have a greater vivacity than thofe of imagination: but the ideas of a perfon in fleep, or in a waking reverie, where the trains connected with fenfation are uninterrupted, are more vivid and diftinct than thofe of memory, fo that they cannot be diftinguifhed by this criterion.

The very ingenious author of the Elements of Criticifm has defcribed what he conceives to be a fpecies of memory, and calls it ideal prefence; but the inftances he produces are the reveries of fenfation, and are therefore in truth connexions of the imagination, though they are recalled in the order they were received.

The ideas connected by affociation are in common difcourfe attributed to memory, as we talk of memorandum-rings, and tie a knot on our handkerchiefs to bring fomething into our minds at a diftance of time. And a fchool-boy who can repeat a thoufand unmeaning lines in Lilly's Grammar, is faid to have a good memory. But thefe have been already fhewn to belong to the

clafs of aſſociation; and are termed ideas of ſuggeſtion.

II. Laſtly, the method already explained of claſſing ideas into thoſe excited by irritation, ſenſation, volition, or aſſociation, we hope will be found more convenient both for explaining the operations of the mind, and for comparing them with thoſe of the body; and for the illuſtration and the cure of the diſeaſes of both, and which we ſhall here recapitulate.

1. Irritative ideas are thoſe, which are preceded by irritation, which is excited by objects external to the organs of ſenſe: as the idea of that tree, which either I attend to, or which I ſhun in walking near it without attention. In the former caſe it is termed perception, in the latter it is termed ſimply an irritative idea.

2. Senſitive ideas are thoſe, which are preceded by the ſenſation of pleaſure or pain; as the ideas, which conſtitute our dreams or reveries, this is called imagination.

3. Voluntary ideas are thoſe, which are preceded by voluntary exertion, as when I repeat the alphabet backwards: this is called recollection.

4. Aſſociate ideas are thoſe, which are preceded by other ideas or muſcular motions, as when we think over or repeat the alphabet by rote in its uſual order; or ſing a tune we are accuſtomed to; this is called ſuggeſtion.

III. 1. Perceptions ſignify thoſe ideas, which

are

are preceded by irritation and ſucceeded by the ſenſation of pleaſure or pain, for whatever excites our attention intereſts us; that is, it is accompanied with pleaſure or pain; however ſlight may be the degree or quantity of either of them.

The word memory includes two claſſes of ideas, either thoſe which are preceded by voluntary exertion, or thoſe which are ſuggeſted by their aſſociations with other ideas.

2. Reaſoning is that operation of the ſenſorium, by which we excite two or many tribes of ideas; and then re-excite the ideas, in which they differ, or correſpond. If we determine this difference, it is called judgment; if we in vain endeavour to determine it, it is called doubting.

If we re-excited the ideas, in which they differ, it is called diſtinguiſhing. If we re-excite thoſe in which they correſpond, it is called comparing.

3. Invention is an operation of the ſenſorium, by which we voluntarily continue to excite one train of ideas, ſuppoſe the deſign of raiſing water by a machine; and at the ſame time attend to all other ideas, which are connected with this by every kind of catenation; and combine or ſeparate them voluntarily for the purpoſe of obtaining ſome end.

For we can create nothing new, we can only combine or ſeparate the ideas, which we have already received by our perceptions: thus if I wiſh to repreſent a monſter, I call to my mind the

ideas of every thing disagreeable and horrible, and combine the nastiness and gluttony of a hog, the stupidity and obstinacy of an ass, with the fur and awkwardness of a bear, and call the new combination Caliban. Yet such a monster may exist in nature, as all his attributes are parts of nature. So when I wish to represent every thing, that is excellent, and amiable; when I combine benevolence with cheerfulness, wisdom, knowledge, taste, wit, beauty of person, and elegance of manners, and associate them in one lady as a pattern to the world, it is called invention; yet such a person may exist,—such a person does exist!—It is ——— ———, who is as much a monster as Caliban.

4. In respect to consciousness, we are only conscious of our existence, when we think about it; as we only perceive the lapse of time, when we attend to it; when we are busied about other objects, neither the lapse of time nor the consciousness of our own existence can occupy our attention. Hence, when we think of our own existence, we only excite abstracted or reflex ideas (as they are termed), of our principal pleasures or pains, of our desires or aversions, or of the figure, solidity, colour, or other properties of our bodies, and call that act of the sensorium a consciousness of our existence. Some philosophers, I believe it is Des Cartes, has said, "I think, therefore I exist." But this is not right reasoning, because thinking

thinking is a mode of exiſtence; and it is thence only ſaying, "I exiſt, therefore I exiſt." For there are three modes of exiſtence, or in the language of grammarians three kinds of verbs. Firſt, ſimply I am, or exiſt. Secondly, I am acting, or exiſt in a ſtate of activity, as I move. Thirdly, I am ſuffering, or exiſt in a ſtate of being acted upon, as I am moved. The when, and the where, as applicable to this exiſtence, depends on the ſucceſſive motions of our own or of other bodies; and on their reſpective ſituations, as ſpoken of Sect. XIV. 2. 5.

5. Our identity is known by our acquired habits or catenated trains of ideas and muſcular motions; and perhaps, when we compare infancy with old age, in thoſe alone can our identity be ſuppoſed to exiſt. For what elſe is there of ſimilitude between the firſt ſpeck of living entity and the mature man?—every deduction of reaſoning, every ſentiment or paſſion, with every fibre of the corporeal part of our ſyſtem, has been ſubject almoſt to annual mutation; while ſome catenations alone of our ideas and muſcular actions have continued in part unchanged.

By the facility, with which we can in our waking hours voluntarily produce certain ſucceſſive trains of ideas, we know by experience, that we have before reproduced them; that is, we are conſcious of a time of our exiſtence previous to the preſent time; that is, of our identity now and heretofore.

It is theſe habits of action, theſe catenations of ideas and muſcular motions, which begin with life, and only terminate with it; and which we can in ſome meaſure deliver to our poſterity; as explained in Sect. XXXIX.

6. When the progreſſive motions of external bodies make a part of our preſent catenation of ideas, we attend to the lapſe of time; which appears the longer, the more frequently we thus attend to it; as when we expect ſomething at a certain hour, which much intereſts us, whether it be an agreeable or diſagreeable event; or when we count the paſſing ſeconds on a ſtop-watch.

When an idea of our own perſon, or a reflex idea of our pleaſures and pains, deſires and averſions, makes a part of this catenation, it is termed conſciouſneſs; and if this idea of conſciouſneſs makes a part of a catenation, which we excite by recollection, and know by the facility with which we excite it, that we have before experienced it, it is called identity, as explained above.

7. In reſpect to freewill, it is certain, that we cannot will to think of a new train of ideas, without previouſly thinking of the firſt link of it; as I cannot will to think of a black ſwan, without previouſly thinking of a black ſwan. But if I now think of a tail, I can voluntarily recollect all animals, which have tails; my will is ſo far free, that I can purſue the ideas linked to this idea

idea of tail, as far as my knowledge of the ſub-ject extends; but to will without motive is to will without deſire or averſion; which is as ab-ſurd as to feel without pleaſure or pain; they are both ſolecifms in the terms. So far are we go-verned by the catenations of motions, which af-fect both the body and the mind of man, and which begin with our irritability, and end with it.

# SECT. XVI.

## OF INSTINCT.

HAUD EQUIDEM CREDO, QUIA SIT DIVINITUS ILLIS INGENIUM, AUT RERUM FATO PRUDENTIA MAJOR.

VIRG. GEORG. L. I. 415.

I. *Instinctive actions defined. Of connate passions.* II. *Of the sensations and motions of the fœtus in the womb.* III. *Some animals are more perfectly formed than others before nativity. Of learning to walk.* IV. *Of the swallowing, breathing, sucking, pecking, and lapping of young animals.* V. *Of the sense of smell, and its uses to animals. Why cats do not eat their kittens.* VI. *Of the accuracy of sight in mankind, and their sense of beauty. Of the sense of touch in elephants, monkies, beavers, men.* VII. *Of natural language.* VIII. *The origin of natural language;* 1. *the language of fear;* 2. *of grief;* 3. *of tender pleasure;* 4. *of serene pleasure;* 5. *of anger;* 6. *of attention.* IX. *Artificial language of turkies, hens, ducklings, wagtails, cuckoos, rabbits, dogs, and nightingales.* X. *Of music; of tooth-edge; of a good ear; of architecture.* XI. *Of acquired knowledge; of foxes, rooks, feildfares, lapwings, dogs, cats, horses, crows, pelicans, the tiger, and rattlesnake.* XII. *Of birds of passage, dormice, snakes, bats, swallows, quails, ring-doves, the stare, chaffinch, hoopoe, chatterer, hawfinch, cross-bill, rails and cranes.* XIII. *Of birds nests; of the cuckoo; of swallows nests; of the taylor bird.* XIV. *Of the old soldier; of haddocks, cods, and dog-fish; of the remora; of crabs,*

*crabs, herrings, and ſalmon.* XV. *Of ſpiders, caterpillars, ants, and the ichneumon.* XVI. 1. *Of locuſts, gnats;* 2. *bees;* 3. *dormice, flies, worms, ants, and waſps.* XVII. *Of the faculty that diſtinguiſhes man from the brutes.*

I. ALL thoſe internal motions of animal bodies, which contribute to digeſt their aliment, produce their ſecretions, repair their injuries, or increaſe their growth, are performed without our attention or conſciouſneſs. They exiſt as well in our ſleep, as in our waking hours, as well in the fœtus during the time of geſtation, as in the infant after nativity, and proceed with equal regularity in the vegetable as in the animal ſyſtem. Theſe motions have been ſhewn in a former part of this work to depend on the irritations of peculiar fluids, and as they have never been claſſed amongſt the inſtinctive actions of animals, are precluded from our preſent diſquiſition.

But all thoſe actions of men or animals, that are attended with conſciouſneſs, and ſeem neither to have been directed by their appetites, taught by their experience, nor deduced from obſervation or tradition, have been referred to the power of inſtinct. And this power has been explained to be a *divine ſomething*, a kind of inſpiration; whilſt the poor animal, that poſſeſſes it, has been thought little better than *a machine!*

The *irkſomeneſs*, that attends a continued attitude of the body, or the *pains*, that we receive from

from heat, cold, hunger, or other injurious circumſtances, excite us to *general locomotion:* and our ſenſes are ſo formed and conſtituted by the hand of nature, that certain objects preſent us with pleaſure, others with pain, and we are induced to approach and embrace theſe, to avoid and abhor thoſe, as ſuch ſenſations direct us.

Thus the palates of ſome animals are gratefully affected by the maſtication of fruits, others of grains, and others of fleſh; and they are thence inſtigated to attain, and conſume thoſe materials; and are furniſhed with powers of muſcular motion, and of digeſtion proper for ſuch purpoſes.

Theſe *ſenſations* and *deſires* conſtitute a part of our ſyſtem, as our *muſcles* and *bones* conſtitute another part: and hence they may alike be termed *natural* or *connate*; but neither of them can properly be termed *inſtinctive:* as the word inſtinct in its uſual acceptation refers only to the *actions* of animals, as above explained: the origin of theſe *actions* is the ſubject of our preſent inquiry.

The reader is entreated carefully to attend to this definition of *inſtinctive actions*, leſt by uſing the word inſtinct without adjoining any accurate idea to it, he may not only include the natural deſires of love and hunger, and the natural ſenſations of pain or pleaſure, but the figure and contexture of the body, and the faculty of reaſon itſelf, under this general term.

II. We experience ſome ſenſations, and perform

form ſome actions before our nativity; the ſenſations of cold and warmth, agitation and reſt, fulneſs and inanition, are inſtances of the former; and the repeated ſtruggles of the limbs of the fœtus, which begin about the middle of geſtation, and thoſe motions by which it frequently wraps the umbilical chord around its neck or body, and even ſometimes ties it in a knot; are inſtances of the latter. (Smellie's Midwifery, Vol. I. p. 182.)

By a due attention to theſe circumſtances many of the actions of young animals, which at firſt ſight ſeemed only referable to an inexplicable inſtinct, will appear to have been acquired like all other animal actions, that are attended with conſciouſneſs, *by the repeated efforts of our muſcles under the conduct of our ſenſations or deſires.*

The chick in the ſhell begins to move its feet and legs on the ſixth day of incubation (Mattreican, p. 138); or on the ſeventh day, (Langley); afterwards it is ſeen to move itſelf gently in the liquid that ſurrounds it, and to open and ſhut its mouth, (Harvei, de Generat. p. 62, and 197. Form. de Poulet. ii. p. 129). Puppies before the membranes are broken, that involve them, are ſeen to move themſelves, to put out their tongues, and to open and ſhut their mouths, (Harvey, Gipſon, Riolan, Haller). And calves lick themſelves and ſwallow many of their hairs before their nativity: which however puppies do not,

not, (Swammerdam, p. 319. Flemyng Phil. Tranf. Ann. 1755, 42). And towards the end of geftation, the fœtufes of all animals are proved to drink part of the liquid in which they fwim, (Haller. Phyfiol. T. 8. 204). The white of egg is found in the mouth and gizzard of the chick, and is nearly or quite confumed before it is hatched, (Harvei de Generat. 58). And the liquor amnii is found in the mouth and ftomach of the human fœtus, and of calves; and how elfe fhould that excrement be produced in the inteftines of all animals, which is voided in great quantity foon after their birth; (Gipfon, Med. Effays, Edinb. V. i. 13. Halleri Phyfiolog. T. 3. p. 318. and T. 8.) In the ftomach of a calf the quantity of this liquid amounted to about three pints, and the hairs amongft it were of the fame colour with thofe on its fkin, (Blafii Anat. Animal, p. m. 122). Thefe facts are attefted by many other writers of credit, befides thofe above mentioned.

III. It has been deemed a furprifing inftance of inftinct, that calves and chickens fhould be able to walk by a few efforts almoft immediately after their nativity: whilft the human infant in thofe countries where he is not incumbered with clothes, as in India, is five or fix months, and in our climate almoft a twelvemonth, before he can fafely ftand upon his feet.

The ftruggles of all animals in the womb muft refemble their mode of fwimming, as by this

kind

kind of motion they can beſt change their attitude in water. But the ſwimming of the calf and chicken reſembles their manner of walking, which they have thus in part acquired before their nativity, and hence accompliſh it afterwards with very few efforts, whilſt the ſwimming of the human creature reſembles that of the frog, and totally differs from his mode of walking.

There is another circumſtance to be attended to in this affair, that not only the growth of thoſe peculiar parts of animals, which are firſt wanted to ſecure their ſubſiſtence, are in general fartheſt advanced before their nativity: but ſome animals come into the world more completely formed throughout their whole ſyſtem than others; and are thence much forwarder in all their habits of motion. Thus the colt, and the lamb, are much more perfect animals than the blind puppy, and the naked rabbit; and the chick of the pheaſant, and the partridge, has more perfect plumage, and more perfect eyes, as well as greater aptitude to locomotion, than the callow neſtlings of the dove, and of the wren. The parents of the former only find it neceſſary to ſhew them their food, and to teach them to take it up; whilſt thoſe of the latter are obliged for many days to obtrude it into their gaping mouths.

IV. From the facts mentioned in No. 2. of this Section, it is evinced that the fœtus learns to ſwallow before its nativity; for it is ſeen to open

its mouth, and its ſtomach is found filled with the liquid that ſurrounds it. It opens its mouth, either inſtigated by hunger, or by the irkſomeneſs of a continued attitude of the muſcles of its face; the liquor amnii, in which it ſwims, is agreeable to its palate, as it conſiſts of a nouriſhing material, (Haller. Phyſ. T. 8. p. 204). It is tempted to experience its taſte further in the mouth, and by a few efforts learns to ſwallow, in the ſame manner as we learn all other animal actions, which are attended with conſciouſneſs, *by the repeated efforts of our muſcles under the conduct of our ſenſations or volitions.*

The inſpiration of air into the lungs is ſo totally different from that of ſwallowing a fluid in which we are immerſed, that it cannot be acquired before our nativity. But at this time, when the circulation of the blood is no longer continued through the placenta, that ſuffocating ſenſation, which we feel about the precordia, when we are in want of freſh air, diſagreeably affects the infant: and all the muſcles of the body are excited into action to relieve this oppreſſion; thoſe of the breaſt, ribs, and diaphragm are found to anſwer this purpoſe, and thus reſpiration is diſcovered, and is continued throughout our lives, as often as the oppreſſion begins to recur. Many infants, both of the human creature, and of quadrupeds, ſtruggle for a minute after they are born before they begin to breathe, (Haller. Phyſ. T. 8. p. 400.

p. 400. ib. pt. 2. p. 1). Mr. Buffon thinks the action of the dry air upon the nerves of ſmell of new-born animals, by producing an endeavour to ſneeze, may contribute to induce this firſt inſpiration, and that the rarefaction of the air by the warmth of the lungs contributes to induce expiration, (Hiſt. Nat. Tom. 4. p. 174). Which latter it may effect by producing a diſagreeable ſenſation by its delay, and a conſequent effort to relieve it. Many children ſneeze before they reſpire, but not all, as far as I have obſerved, or can learn from others.

At length, by the direction of its ſenſe of ſmell, or by the officious care of its mother, the young animal approaches the odoriferous rill of its future nouriſhment, already experienced to ſwallow. But in the act of ſwallowing, it is neceſſary nearly to cloſe the mouth, whether the creature be immerſed in the fluid it is about to drink, or not: hence, when the child firſt attempts to ſuck, it does not ſlightly compreſs the nipple between its lips, and ſuck as an adult perſon would do, by abſorbing the milk; but it takes the whole nipple into its mouth for this purpoſe, compreſſes it between its gums, and thus repeatedly chewing (as it were) the nipple, preſſes out the milk; exactly in the ſame manner as it is drawn from the teats of cows by the hands of the milkmaid. The celebrated Harvey obſerves, that the fœtus in the womb muſt have ſucked in a part of its

nouriſhment, becauſe it knows how to ſuck the minute it is born, as any one may experience by putting a finger between its lips, and becauſe in a few days it forgets this art of ſucking, and cannot without ſome difficulty again acquire it, (Exercit. de Gener. Anim. 48). The ſame obſervation is made by Hippocrates.

A little further experience teaches the young animal to ſuck by abſorption, as well as by compreſſion; that is, to open the cheſt as in the beginning of reſpiration, and thus to rarefy the air in the mouth, that the preſſure of the denſer external atmoſphere may contribute to force out the milk.

The chick yet in the ſhell has learnt to drink by ſwallowing a part of the white of the egg for its food; but not having experienced how to take up and ſwallow ſolid ſeeds, or grains, is either taught by the ſolicitous induſtry of its mother; or by many repeated attempts is enabled at length to diſtinguiſh and to ſwallow this kind of nutriment.

And puppies, though they know how to ſuck like other animals from their previous experience in ſwallowing, and in reſpiration; yet are they long in acquiring the art of lapping with their tongues, which from the flaccidity of their cheeks, and length of their mouths, is afterwards a more convenient way for them to take in water.

V. The ſenſes of ſmell and taſte in many other animals

animals greatly excel thoſe of mankind, for in civilized ſociety, as our victuals are generally prepared by others, and are adulterated with ſalt, ſpice, oil, and empyreuma, we do not heſitate about eating whatever is ſet before us, and neglect to cultivate theſe ſenſes: whereas other animals try every morſel by the ſmell, before they take it into their mouths, and by the taſte before they ſwallow it; and are led not only each to his proper nouriſhment by this organ of ſenſe, but it alſo at a maturer age directs them in the gratification of their appetite of love. Which may be further underſtood by conſidering the ſympathies of theſe parts deſcribed in Claſs IV. 2. 1. 7. While the human animal is directed to the object of his love by his ſenſe of beauty, as mentioned in No. VI. of this Section. Thus Virgil. Georg. III. 250.

Nonne vides, ut tota tremor pertentat equorum
Corpora, ſi tantum notas odor attulit auras?

Nonne canis nidum veneris naſutus odore
Quærit, et erranti trahitur ſublambere linguâ?
Reſpuit at guſtum cupidus, labiiſque retractis
Elevat os, trepidanſque novis impellitur æſtris
Inſerit et vivum felici vomere ſemen.—
Quam tenui filo cæcos adnectit amores
Docta Venus, vitæque monet renovare favillam!
Anon.

The following curious experiment is related by

Galen. "On diffecting a goat great with young I found a brifk embryon, and having detached it from the matrix, and fnatching it away before it faw its dam, I brought it into a certain room, where there were many veffels, fome filled with wine, others with oil, fome with honey, others with milk, or fome other liquor; and in others were grains and fruits; we firft obferved the young animal get upon its feet, and walk; then it fhook itfelf, and afterwards fcratched its fide with one of its feet: then we faw it fmelling to every one of thefe things, that were fet in the room; and when it had fmelt to them all, it drank up the milk." L. 6. de locis. cap. 6.

Parturient quadrupeds, as cats, and bitches, and fows, are led by their fenfe of fmell to eat the placenta as other common food; why then do they not devour their whole progeny, as is reprefented in an antient emblem of TIME? This is faid fometimes to happen in the unnatural ftate in which we confine fows; and indeed nature would feem to have endangered her offfpring in this nice circumftance! But at this time the ftimulus of the milk in the tumid teats of the mother excites her to look out for, and to defire fome unknown circumftance to relieve her. At the fame time the fmell of the milk attracts the exertions of the young animals towards its fource, and thus the delighted mother difcovers a new appetite, as mentioned in Sect. XIV. 8. and her little progeny are led to receive and to

communicate

communicate pleafure by this moft beautiful contrivance.

VI. But though the human fpecies in fome of their fenfations are much inferior to other animals, yet the accuracy of the fenfe of touch, which they poffefs in fo eminent a degree, gives them a great fuperiority of underftanding; as is well obferved by the ingenious Mr. Buffon. The extremities of other animals terminate in horns, and hoofs, and claws, very unfit for the fenfation of touch; whilft the human hand is finely adapted to encompafs its object with this organ of fenfe.

The elephant is indeed endued with a fine fenfe of feeling at the extremity of his probofcis, and hence has acquired much more accurate ideas of touch and of fight than moft other creatures. The two following inftances of the fagacity of thefe animals may entertain the reader, as they were told me by fome gentlemen of diftinct obfervation, and undoubted veracity, who had been much converfant with our eaftern fettlements. Firft, the elephants that are ufed to carry the baggage of our armies, are put each under the care of one of the natives of Indoftan, and whilft himfelf and his wife go into the woods to collect leaves and branches of trees for his food, they fix him to the ground by a length of chain, and frequently leave a child yet unable to walk, under his protection: and the intelligent animal not only defends it, but as it creeps about, when

it arrives near the extremity of his chain, he wraps his trunk gently round its body, and brings it again into the centre of his circle. Secondly, the traitor elephants are taught to walk on a narrow path between two pit-falls, which are covered with turf, and then to go into the woods, and to feduce the wild elephants to come that way, who fall into thefe wells, whilft he paffes fafe between them: and it is univerfally obferved, that thofe wild elephants that efcape the fnare, purfue the traitor with the utmoft vehemence, and if they can overtake him, which fometimes happens, they always beat him to death.

The monkey has a hand well enough adapted for the fenfe of touch, which contributes to his great facility of imitation; but in taking objects with his hands, as a ftick or an apple, he puts his thumb on the fame fide of them with his fingers, inftead of counteracting the preffure of his fingers with it: from this neglect he is much flower in acquiring the figures of objects, as he is lefs able to determine the diftances or diameters of their parts, or to diftinguifh their vis inertiæ from their hardnefs. Helvetius adds, that the fhortnefs of his life, his being fugitive before mankind, and his not inhabiting all climates, combine to prevent his improvement. (De l'Efprit. T. 1. p.) There is however at this time an old monkey fhewn in Exeter Change, London, who having

having loſt his teeth, when nuts are given him, takes a ſtone into his hand, and cracks them with it one by one; thus uſing tools to effect his purpoſe like mankind.

The beaver is another animal that makes much uſe of his hands, and if we may credit the reports of travellers, is poſſeſſed of amazing ingenuity. This however, M. Buffon affirms, is only where they exiſt in large numbers, and in countries thinly peopled with men; while in France in their ſolitary ſtate they ſhew no uncommon ingenuity.

Indeed all the quadrupeds, that have collar-bones, (claviculæ) uſe their fore-limbs in ſome meaſure as we uſe our hands, as the cat, ſquirrel, tyger, bear and lion; and as they exerciſe the ſenſe of touch more univerſally than other animals, ſo are they more ſagacious in watching and ſurpriſing their prey. All thoſe birds, that uſe their claws for hands, as the hawk, parrot, and cuckoo, appear to be more docile and intelligent; though the gregarious tribes of birds have more acquired knowledge.

Now as the images, that are painted on the retina of the eye, are no other than ſigns, which recall to our imaginations the objects we had before examined by the organ of touch, as is fully demonſtrated by Dr. Berkley in his treatiſe on viſion; it follows that the human creature has greatly more accurate and diſtinct ſenſe of

 viſion

viſion than that of any other animal. Whence as he advances to maturity he gradually acquires a ſenſe of female beauty, which at this time directs him to the object of his new paſſion.

Sentimental love, as diſtinguiſhed from the animal paſſion of that name, with which it is frequently accompanied, conſiſts in the deſire or ſenſation of beholding, embracing, and ſaluting a beautiful object.

The characteriſtic of beauty therefore is that it is the object of love and though many other objects are in common language called beautiful, yet they are only called ſo metaphorically, and ought to be termed agreeable. A Grecian temple may give us the pleaſurable idea of ſublimity, a Gothic temple may give us the pleaſurable idea of variety, and a modern houſe the pleaſurable idea of utility; muſic and poetry may inſpire our love by aſſociation of ideas; but none of theſe, except metaphorically, can be termed beautiful; as we have no wiſh to embrace or ſalute them.

Our perception of beauty conſiſts in our recognition by the ſenſe of viſion of thoſe objects, firſt, which have before inſpired our love by the pleaſure, which they have afforded to many of our ſenſes: as to our ſenſe of warmth, of touch, of ſmell, of taſte, hunger and thirſt; and, ſecondly, which bear any analogy of form to ſuch objects.

When the babe, ſoon after it is born into this cold world, is applied to its mother's boſom; its ſenſe

fenfe of perceiving warmth is firft agreeably affected; next its fenfe of fmell is delighted with the odour of her milk; then its tafte is gratified by the flavour of it; afterwards the appetites of hunger and of thirft afford pleafure by the poffeffion of their objects, and by the fubfequent digeftion of the aliment; and, laftly, the fenfe of touch is delighted by the foftnefs and fmoothnefs of the milky fountain, the fource of fuch variety of happinefs.

All thefe various kinds of pleafure at length become affociated with the form of the mother's breaft; which the infant embraces with its hands, preffes with its lips, and watches with its eyes; and thus acquires more accurate ideas of the form of its mother's bofom, than of the odour and flavour or warmth, which it perceives by its other fenfes. And hence at our maturer years, when any object of vifion is prefented to us, which by its waving or fpiral lines bears any fimilitude to the form of the female bofom, whether it be found in a landfcape with foft gradations of rifing and defcending furface, or in the forms of fome antique vafes, or in other works of the pencil or the chiffel, we feel a general glow of delight, which feems to influence all our fenfes; and, if the object be not too large, we experience an attraction to embrace it with our arms, and to falute it with our lips, as we did in our early infancy the bofom of our mother. And thus we find, according to the ingenious

ingenious idea of Hogarth, that the waving lines of beauty were originally taken from the temple of Venus.

This animal attraction is love; which is a sensation, when the object is present; and a desire, when it is absent. Which constitutes the purest source of human felicity, the cordial drop in the otherwise vapid cup of life, and which overpays mankind for the care and labour, which are attached to the pre-eminence of his situation above other animals.

It should have been observed, that colour as well as form sometimes enters into our idea of a beautiful object, as a good complexion for instance, because a fine or fair colour is in general a sign of health, and conveys to us an idea of the warmth of the object; and a pale countenance on the contrary gives an idea of its being cold to the touch.

It was before remarked, that young animals use their lips to distinguish the forms of things, as well as their fingers, and hence we learn the origin of our inclination to salute beautiful objects with our lips. For a definition of Grace, see Class III. 1. 2. 4.

VII. There are two ways by which we become acquainted with the passions of others: first, by having observed the effects of them, as of fear or anger, on our own bodies, we know at sight

when

when others are under the influence of thefe affections. So when two cocks are preparing to fight, each feels the feathers rife round his own neck, and knows from the fame fign the difpofition of his adverfary: and children long before they can fpeak, or underftand the language of their parents, may be frightened by an angry countenance, or foothed by fmiles and blandifhments.

Secondly, when we put ourfelves into the attitude that any paffion naturally occafions, we foon in fome degree acquire that paffion; hence when thofe that fcold indulge themfelves in loud oaths, and violent actions of the arms, they increafe their anger by the mode of expreffing themfelves: and on the contrary the counterfeited fmile of pleafure in difagreeable company foon brings along with it a portion of the reality, as is well illuftrated by Mr. Burke, (Effay on the Sublime and Beautiful.)

This latter method of entering into the paffions of others is rendered of very extenfive ufe by the pleafure we take in imitation, which is every day prefented before our eyes, in the actions of children, and indeed in all the cuftoms and fafhions of the world. From this our aptitude to imitation, arifes what is generally underftood by the word fympathy fo well explained by Dr. Smith of Glafgow. Thus the appearance of a cheerful countenance gives us pleafure, and of a melancholy

choly one makes us ſorrowful. Yawning and ſometimes vomiting are thus propagated by ſympathy, and ſome people of delicate fibres, at the preſence of a ſpectacle of miſery, have felt pain in the ſame parts of their own bodies, that were diſeaſed or mangled in the other. Amongſt the writers of antiquity Ariſtotle thought this aptitude to imitation an eſſential property of the human ſpecies, and calls man an imitative animal. Το ζωον μιμωμενον.

Theſe then are the natural ſigns by which we underſtand each other, and on this ſlender baſis is built all human language. For without ſome natural ſigns, no artificial ones could have been invented or underſtood, as is very ingeniouſly obſerved by Dr. Reid, (Inquiry into the Human Mind.)

VIII. The origin of this univerſal language is a ſubject of the higheſt curioſity, the knowledge of which has always been thought utterly inacceſſible. A part of which we ſhall however here attempt.

Light, ſound, and odours, are unknown to the fœtus in the womb, which, except the few ſenſations and motions already mentioned, ſleeps away its time inſenſible of the buſy world. But the moment it arrives into day, it begins to experience many vivid pains and pleaſures; theſe are at the ſame time attended with certain muſcular motions, and from this their early, and individual

affociation,

aſſociation, they acquire habits of occurring together, that are afterwards indiſſoluble.

### 1. *Of Fear.*

As ſoon as the young animal is born, the firſt important ſenſations, that occur to him, are occaſioned by the oppreſſion about his precordia for want of reſpiration, and by his ſudden tranſition from ninety-eight degrees of heat into ſo cold a climate.—He trembles, that is, he exerts alternately all the muſcles of his body, to enfranchiſe himſelf from the oppreſſion about his boſom, and begins to breathe with frequent and ſhort reſpirations; at the ſame time the cold contracts his red ſkin, gradually turning it pale; the contents of the bladder and of the bowels are evacuated: and from the experience of theſe firſt diſagreeable ſenſations the paſſion of fear is excited, which is no other than the expectation of diſagreeable ſenſations. This early aſſociation of motions and ſenſations perſiſts throughout life; the paſſion of fear produces a cold and pale ſkin, with tremblings, quick reſpiration, and an evacuation of the bladder and bowels, and thus conſtitutes the natural or univerſal language of this paſſion.

On obſerving a Canary bird this morning, January 28, 1772, at the houſe of Mr. Harvey, near Tutbury, in Derbyſhire, I was told it always fainted away, when its cage was cleaned, and deſired

desired to see the experiment. The cage being taken from the ceiling, and its bottom drawn out, the bird began to tremble, and turned quite white about the root of his bill: he then opened his mouth as if for breath, and respired quick, stood straighter up on his perch, hung his wings, spread his tail, closed his eyes, and appeared quite stiff and cataleptic for near half an hour, and at length with much trembling and deep respirations came gradually to himself.

## 2. *Of Grief.*

That the internal membrane of the nostrils may be kept always moist, for the better perception of odours, there are two canals, that conduct the tears after they have done their office in moistening and cleaning the ball of the eye into a sack, which is called the lacrymal sack; and from which there is a duct, that opens into the nostrils: the aperture of this duct is formed of exquisite sensibility, and when it is stimulated by odorous particles, or by the dryness or coldness of the air, the sack contracts itself, and pours more of its contained moisture on the organ of smell. By this contrivance the organ is rendered more fit for perceiving such odours, and is preserved from being injured by those that are more strong or corrosive. Many other receptacles of peculiar fluids disgorge their contents, when the

ends

ends of their ducts are ſtimulated; as the gall bladder, when the contents of the duodenum ſtimulate the extremity of the common bile duct: and the ſalivary glands, when the termination of their ducts in the mouth are excited by the ſtimulus of the food we maſticate. Atque veſiculæ ſeminales ſuum exprimunt fluidum glande penis fricatâ.

The coldneſs and dryneſs of the atmoſphere, compared with the warmth and moiſture, which the new-born infant had juſt before experienced, diſagreeably affect the aperture of this lacrymal ſack: the tears, that are contained in this ſack, are poured into the noſtrils, and a further ſupply is ſecreted by the lacrymal glands, and diffuſed upon the eye-balls; as is very viſible in the eyes and noſtrils of children ſoon after their nativity. The ſame happens to us at our maturer age, for in ſevere froſty weather, ſnivelling and tears are produced by the coldneſs and dryneſs of the air.

But the lacrymal glands, which ſeparate the tears from the blood, are ſituated on the upper external part of the globes of each eye; and, when a greater quantity of tears are wanted, we contract the forehead, and bring down the eye-brows, and uſe many other diſtortions of the face, to compreſs theſe glands.

Now as the ſuffocating ſenſation, that produces reſpiration, is removed almoſt as ſoon as perceived, and does not recur again: this diſagree-

able

able irritation of the lacrymal ducts, as it must frequently recur, till the tender organ becomes used to variety of odours, is one of the first pains that is repeatedly attended to: and hence throughout our infancy, and in many people throughout their lives, all disagreeable sensations are attended with snivelling at the nose, a profusion of tears, and some peculiar distortions of countenance: according to the laws of early association before mentioned, which constitutes the natural or universal language of grief.

You may assure yourself of the truth of this observation, if you will attend to what passes, when you read a distressful tale alone; before the tears overflow your eyes, you will invariably feel a titillation at that extremity of the lacrymal duct, which terminates in the nostril, then the compression of the eyes succeeds, and the profusion of tears.

Linnæus asserts, that the female bear sheds tears in grief; the same has been said of the hind, and some other animals.

### 3. *Of Tender Pleasure.*

The first most lively impression of pleasure, that the infant enjoys after its nativity, is excited by the odour of its mother's milk. The organ of smell is irritated by this perfume, and the lacrymal sack empties itself into the nostrils, as

before

before explained, and an increafe of tears is poured into the eyes. Any one may obferve this, when very young infants are about to fuck; for at thofe early periods of life, the fenfation affects the organ of fmell, much more powerfully, than after the repeated habit of fmelling has inured it to odours of common ftrength: and in our adult years, the ftronger fmells, though they are at the fame time agreeable to us, as of volatile fpirits, continue to produce an increafed fecretion of tears.

The pleafing fenfation of fmell is followed by the early affection of the infant to the mother that fuckles it, and hence the tender feelings of gratitude and love, as well as of hopelefs grief, are ever after joined with the titillation of the extremity of the lacrymal ducts, and a profufion of tears.

Nor is it fingular, that the lacrymal fack fhould be influenced by pleafing ideas, as the fight of agreeable food produces the fame effect on the falivary glands. Ac dum vidimus in fomniis lafcivæ puellæ fimulacrum tenditur penis.

Lambs fhake or wriggle their tails, at the time when they firft fuck, to get free of the hard excrement, which had been long lodged in their bowels. Hence this becomes afterwards a mark of pleafure in them, and in dogs, and other tailed animals. But cats gently extend and con-

tract their paws when they are pleafed, and purr by drawing in their breath, both which refemble their manner of fucking, and thus become their language of pleafure, for thefe animals having collar-bones ufe their paws like hands when they fuck, which dogs and fheep do not.

### 4. *Of Serene Pleafure.*

In the action of fucking, the lips of the infant are clofed around the nipple of his mother, till he has filled his ftomach, and the pleafure occafioned by the ftimulus of this grateful food fucceeds. Then the fphincter of the mouth, fatigued by the continued action of fucking, is relaxed; and the antagonift mufcles of the face gently acting, produce the fmile of pleafure: as cannot but be feen by all who are converfant with children.

Hence this fmile during our lives is affociated with gentle pleafure; it is vifible in kittens, and puppies, when they are played with, and tickled; but more particularly marks the human features. For in children this expreffion of pleafure is much encouraged, by their imitation of their parents, or friends; who generally addrefs them with a fmiling countenance: and hence fome nations are more remarkable for the gaiety, and others for the gravity of their looks.

5. *Of*

### 5. *Of Anger.*

The actions that conſtitute the mode of fighting, are the immediate language of anger in all animals; and a preparation for theſe actions is the natural language of threatening. Hence the human creature clenches his fiſt, and ſternly ſurveys his adverſary, as if meditating where to make the attack; the ram, and the bull, draws himſelf ſome ſteps backwards, and levels his horns; and the horſe, as he moſt frequently fights by ſtriking with his hinder feet, turns his heels to his foe, and bends back his ears, to liſten out the place of his adverſary, that the threatened blow may not be ineffectual.

### 6. *Of Attention.*

The eye takes in at once but half our horizon, and that only in the day, and our ſmell informs us of no very diſtant objects, hence we confide principally in the organ of hearing to apprize us of danger; when we hear any the ſmalleſt ſound, that we cannot immediately account for, our fears are alarmed, we ſuſpend our ſteps, hold every muſcle ſtill, open our mouths a little, erect our ears, and liſten to gain further information: and this by habit becomes the general language of attention to objects of ſight, as well as of

hearing; and even to the fucceffive trains of our ideas.

The natural language of violent pain, which is expreffed by writhing the body, grinning, and fcreaming; and that of tumultuous pleafure, expreffed in loud laughter; belong to Section XXXIV. on Difeafes from Volition.

IX. It muft have already appeared to the reader, that all other animals, as well as man, are poffeffed of this natural language of the paffions, expreffed in figns or tones; and we fhall endeavour to evince, that thofe animals, which have preferved themfelves from being enflaved by mankind, and are affociated in flocks, are alfo poffeffed of fome artificial language, and of fome traditional knowledge.

The mother-turkey, when fhe eyes a kite hovering high in air, has either feen her own parents thrown into fear at his prefence, or has by obfervation been acquainted with his dangerous defigns upon her young. She becomes agitated with fear, and ufes the natural language of that paffion, her young ones catch the fear by imitation, and in an inftant conceal themfelves in the grafs.

At the fame time that fhe fhews her fears by her gefture and deportment, fhe ufes a certain exclamation, Koe-ut, Koe-ut, and the young ones afterwards know, when they hear this note, though they do not fee their dam, that the pre-

fence

ſence of their adverſary is denounced, and hide themſelves as before.

The wild tribes of birds have very frequent opportunities of knowing their enemies, by obſerving the deſtruction they make among their progeny, of which every year but a ſmall part eſcapes to maturity: but to our domeſtic birds theſe opportunities ſo rarely occur, that their knowledge of their diſtant enemies muſt frequently be delivered by tradition in the manner above explained, through many generations.

This note of danger, as well as the other notes of the mother-turkey, when ſhe calls her flock to their food, or to ſleep under her wings, appears to be an artificial language, both as expreſſed by the mother, and as underſtood by the progeny. For a hen teaches this language with equal eaſe to the ducklings, ſhe has hatched from ſuppoſititious eggs, and educates as her own offspring: and the wagtails, or hedge-ſparrows, learn it from the young cuckoo their foſter nurſling, and ſupply him with food long after he can fly about, whenever they hear his cuckooing, which Linneus tells us, is his call of hunger, (Syſt. Nat.) And all our domeſtic animals are readily taught to come to us for food, when we uſe one tone of voice, and to fly from our anger, when we uſe another.

Rabbits, as they cannot eaſily articulate ſounds, and are formed into ſocieties, that live under

ground, have a very different method of giving alarm. When danger is threatened, they thump on the ground with one of their hinder feet, and produce a ſound, that can be heard a great way by animals near the ſurface of the earth, which would ſeem to be an artificial ſign both from its ſingularity and its aptneſs to the ſituation of the animal.

The rabbits on the iſland of Sor, near Senegal, have white fleſh, and are well taſted, but do not burrow in the earth, ſo that we may ſuſpect their digging themſelves houſes in this cold climate is an acquired art, as well as their note of alarm, (Adanſon's Voyage to Senegal).

The barking of dogs is another curious note of alarm, and would ſeem to be an acquired language, rather than a natural ſign: for "in the iſland of Juan Fernandes, the dogs did not attempt to bark, till ſome European dogs were put among them, and then they gradually begun to imitate them, but in a ſtrange manner at firſt, as if they were learning a thing that was not natural to them," (Voyage to South America by Don G. Juan, and Don Ant. de Ulloa. B. 2. c. 4).

Linnæus alſo obſerves, that the dogs of South America do not bark at ſtrangers, (Syſt. Nat). And the European dogs, that have been carried to Guinea, are ſaid in three or four generations to ceaſe to bark, and only howl, like the dogs

that are natives of that coaſt, (World Diſplayed, Vol. XVII. p. 26).

A circumſtance not diſſimilar to this, and equally curious, is mentioned by Kircherus. de Muſurgia, in his Chapter de Luſciniis. "That the young nightingales, that are hatched under other birds, never ſing till they are inſtructed by the company of other nightingales." And Jonſton affirms, that the nightingales, that viſit Scotland, have not the ſame harmony as thoſe of Italy, (Pennant's Zoology, octavo, p. 255); which would lead us to ſuſpect that the ſinging of birds, like human muſic, is an artificial language rather than a natural expreſſion of paſſion.

X. Our muſic like our language, is perhaps entirely conſtituted of artificial tones, which by habit ſuggeſt certain agreeable paſſions. For the ſame combination of notes and tones do not excite devotion, love, or poetic melancholy in a native of Indoſtan and of Europe. And "the Highlander has the ſame warlike ideas annexed to the ſound of a bagpipe (an inſtrument which an Engliſhman derides), as the Engliſhman has to that of a trumpet or fife," (Dr. Brown's Union of Poetry and Muſic, p. 58.) So "the muſic of the Turks is very different from the Italian, and the people of Fez and Morocco have again a different kind, which to us appears very rough and horrid, but is highly pleaſing to them,"

 (L'Arte

(L'Arte Armonica a Giorgio Antoniotto). Hence we ſee why the Italian opera does not delight an untutored Engliſhman; and why thoſe, who are unaccuſtomed to muſic, are more pleaſed with a tune, the ſecond or third time they hear it, than the firſt. For then the ſame melodious train of ſounds excites the melancholy, they had learned from the ſong; or the ſame vivid combination of them recalls all the mirthful ideas of the dance and company.

Even the ſounds, that were once diſagreeable to us, may by habit be aſſociated with other ideas, ſo as to become agreeable. Father Lafitau, in his account of the Iroquois, ſays the muſic and dance of thoſe Americans have ſomething in them extremely barbarous, which at firſt diſguſts. We grow reconciled to them by degrees, and in the end partake of them with pleaſure, the ſavages themſelves are fond of them to diſtraction," (Mœurs des Savages, Tom. ii.)

There are indeed a few ſounds, that we very generally aſſociate with agreeable ideas, as the whiſtling of birds, or purring of animals, that are delighted; and ſome others, that we as generally aſſociate with diſagreeable ideas, as the cries of animals in pain, the hiſs of ſome of them in anger, and the midnight howl of beaſts of prey. Yet we receive no terrible or ſublime ideas from the lowing of a cow, or the braying of an aſs. Which evinces, that theſe emotions are owing to previous aſſoci-

ations,

ations. So if the rumbling of a carriage in the ftreet be for a moment miftaken for thunder, we receive a fublime fenfation, which ceafes as foon as we know it is the noife of a coach and fix.

There are other difagreeable founds, that are faid to fet the teeth on edge; which, as they have always been thought a neceffary effect of certain difcordant notes, become a proper fubject of our inquiry. Every one in his childhood has repeatedly bit a part of the glafs or earthen veffel, in which his food has been given him, and has thence had a very difagreeable fenfation in the teeth, which fenfation was defigned by nature to prevent us from exerting them on objects harder than themfelves. The jarring found produced between the cup and the teeth is always attendant on this difagreeable fenfation: and ever after when fuch a found is accidentally produced by the conflict of two hard bodies, we feel by affociation of ideas the concomitant difagreeable fenfation in our teeth.

Others have in their infancy frequently held the corner of a filk handkerchief in their mouth, or the end of the velvet cape of their coat, whilft their companions in play have plucked it from them, and have given another difagreeable fenfation to their teeth, which has afterwards recurred on touching thofe materials. And the fight of a knife drawn along a china plate, though no found is excited by it, and even the imagination

of

of ſuch a knife and plate ſo ſcraped together, I know by repeated experience will produce the ſame diſagreeable ſenſation of the teeth.

These circumſtances indiſputably prove, that this ſenſation of the tooth-edge is owing to aſſociated ideas; as it is equally excitable by ſight, touch, hearing, or imagination.

In reſpect to the artificial proportions of ſound excited by muſical inſtruments, thoſe, who have early in life aſſociated them with agreeable ideas, and have nicely attended to diſtinguiſh them from each other, are ſaid to have a good ear, in that country where ſuch proportions are in faſhion: and not from any ſuperior perfection in the organ of hearing, or any inſtinctive ſympathy between certain ſounds and paſſions.

I have obſerved a child to be exquiſitely delighted with muſic, and who could with great facility learn to ſing any tune that he heard diſtinctly, and yet whoſe organ of hearing was ſo imperfect, that it was neceſſary to ſpeak louder to him in common converſation than to others.

Our muſic, like our architecture, ſeems to have no foundation in nature, they are both arts purely of human creation, as they imitate nothing. And the profeſſors of them have only claſſed thoſe circumſtances, that are moſt agreeable to the accidental taſte of their age, or country; and have called it Proportion. But this proportion muſt always fluctuate, as it reſts on the caprices, that

are introduced into our minds by our various modes of education. And theſe fluctuations of taſte muſt become more frequent in the preſent age, where mankind have enfranchiſed themſelves from the blind obedience to the rules of antiquity in perhaps every ſcience, but that of architecture. See Sect. XII. 7. 3.

XI. There are many articles of knowledge, which the animals in cultivated countries ſeem to learn very early in their lives, either from each other, or from experience, or obſervation: one of the moſt general of theſe is to avoid mankind. There is ſo great a reſemblance in the natural language of the paſſions of all animals, that we generally know, when they are in a pacific, or in a malevolent humour, they have the ſame knowledge of us; and hence we can ſcold them from us by ſome tones and geſtures, and could poſſibly attract them to us by others, if they were not already apprized of our general malevolence towards them. Mr. Gmelin, Profeſſor at Peterſburg, aſſures us, that in his journey into Siberia, undertaken by order of the Empreſs of Ruſſia, he ſaw foxes that expreſſed no fear of himſelf or companions, but permitted him to come quite near them, having never ſeen the human creature before. And Mr. Bougainville relates, that at his arrival at the Malouine, or Falkland's Iſlands, which were not inhabited by men, all the animals came about himſelf and his people; the fowls

fowls ſettling upon their heads and ſhoulders, and the quadrupeds running about their feet. From the difficulty of acquiring the confidence of old animals, and the eaſe of taming young ones, it appears that the fear, they all conceive at the ſight of mankind, is an acquired article of knowledge.

This knowledge is more nicely underſtood by rooks, who are formed into ſocieties, and build, as it were, cities over our heads; they evidently diſtinguiſh, that the danger is greater when a man is armed with a gun. Every one has ſeen this, who in the ſpring of the year has walked under a rookery with a gun in his hand: the inhabitants of the trees riſe on their wings, and ſcream to the unfledged young to ſhrink into their neſts from the ſight of the enemy. The vulgar obſerving this circumſtance ſo uniformly to occur, aſſert that rooks can ſmell gun-powder.

The fieldfairs, (turdus pilaris) which breed in Norway, and come hither in the cold ſeaſon for our winter berries; as they are aſſociated in flocks, and are in a foreign country, have evident marks of keeping a kind of watch, to remark and announce the appearance of danger. On approaching a tree, that is covered with them, they continue fearleſs till one at the extremity of the buſh riſing on his wings gives a loud and peculiar note of alarm, when they all immediately fly, except one other, who continues till you approach

ſtill nearer, to certify as it were the reality of the danger, and then he alſo flies off repeating the note of alarm.

And in the woods about Senegal there is a bird called uett-uett by the negroes, and ſquallers by the French, which, as ſoon as they ſee a man, ſet up a loud ſcream, and keep flying round him, as if their intent was to warn other birds, which upon hearing the cry immediately take wing. Theſe birds are the bane of ſportſmen, and frequently put me into a paſſion, and obliged me to ſhoot them, (Adanſon's Voyage to Senegal, 78). For the ſame intent the leſſer birds of our climate ſeem to fly after a hawk, cuckoo, or owl, and ſcream to prevent their companions from being ſurpriſed by the general enemies of themſelves, or of their eggs and progeny.

But the lapwing, (charadrius pluvialis Lin.) when her unfledged offspring run about the marſhes, where they were hatched, not only gives the note of alarm at the approach of men or dogs, that her young may conceal themſelves; but flying and ſcreaming near the adverſary, ſhe appears more ſolicitous and impatient, as he recedes from her family, and thus endeavours to miſlead him, and frequently ſucceeds in her deſign. Theſe laſt inſtances are ſo appoſite to the ſituation, rather than to the natures of the creatures, that uſe them; and are ſo ſimilar to the actions of men in the ſame circumſtances, that we

cannot

cannot but believe, that they proceed from a similar principle.

Miſs M. E. Jackſon acquainted me, that ſhe witneſſed this autumn an agreeable inſtance of ſagacity in a little bird, which ſeemed to uſe the means to obtain an end; the bird repeatedly hopped upon a poppy-ſtem, and ſhook the head with its bill, till many ſeeds were ſcattered, then it ſettled on the ground, and eat the ſeeds, and again repeated the ſame management. Sept. 1, 1794.

On the northern coaſt of Ireland a friend of mine ſaw above a hundred crows at once preying upon muſcles; each crow took a muſcle up into the air twenty or forty yards high, and let it fall on the ſtones, and thus by breaking the ſhell, got poſſeſſion of the animal.—A certain philoſopher (I think it was Anaxagoras) walking along the ſea-ſhore to gather ſhells, one of theſe unlucky birds miſtaking his bald head for a ſtone, dropped a ſhell fiſh upon it, and killed at once a philoſopher and an oyſter.

The Martin, hirundo urbica, is ſaid by Linneus to dwell on the outſide of houſes in Europe under the eaves, and to return with the early foliage. And that, when it has built, the ſparrow, fringilla domeſtica, frequently occupies the finiſhed neſt; but that the martin convoking its companions, while ſome guard the captive enemy, others bring clay, exactly cloſe up the entrance, and

and fly away leaving the intruder to be ſuffocated. Syſt. Natur. Paſſ. Hirundo. A ſimilar relation was printed many years ago in the Gentleman's Magazine.

Our domeſtic animals, that have ſome liberty, are alſo poſſeſſed of ſome peculiar traditional knowledge: dogs and cats have been forced into each other's ſociety, though naturally animals of a very different kind, and have hence learned from each other to eat dog's graſs (agroſtis canina) when they are ſick, to promote vomiting. I have ſeen a cat miſtake the blade of barley for this graſs, which evinces it is an acquired knowledge. They have alſo learnt of each other to cover their excrement and urine;—about a ſpoonful of water was ſpilt upon my hearth from the tea-kettle, and I obſerved a kitten cover it with aſhes. Hence this muſt alſo be an acquired art, as the creature miſtook the application of it.

To preſerve their fur clean, and eſpecially their whiſkers, cats waſh their faces, and generally quite behind their ears, every time they eat. As they cannot lick thoſe places with their tongues, they firſt wet the inſide of the leg with ſaliva, and then repeatedly waſh their faces with it, which muſt originally be an effect of reaſoning, becauſe a means is uſed to produce an effect; and ſeems afterwards to be taught or acquired by imitation, like the greateſt part of human arts.

Theſe animals ſeem to poſſeſs ſomething like

an additional ſenſe by means of their whiſkers; which have perhaps ſome analogy to the antennæ of moths and butterflies. The whiſkers of cats conſiſt not only of the long hairs on their upper lips, but they have alſo four or five long hairs ſtanding up from each eyebrow, and alſo two or three on each cheek; all which when the animal erects them, make with their points ſo many parts of the periphery of a circle, of an extent at leaſt equal to the circumference of any part of their own bodies. With this inſtrument, I conceive, by a little experience, they can at once determine, whether any aperture amongſt hedges or ſhrubs, in which animals of this genus live in their wild ſtate, is large enough to admit their bodies; which to them is a matter of the greateſt conſequence, whether purſuing or purſued. They have likewiſe a power of erecting and bringing forward the whiſkers on their lips; which probably is for the purpoſe of feeling, whether a dark hole be further permeable.

The antennæ, or horns of butterflies and moths, who have awkward wings, the minute feathers of which are very liable to injury, ſerve, I ſuppoſe, a ſimilar purpoſe of meaſuring, as they fly or creep amongſt the leaves of plants and trees, whither their wings can paſs without touching them.

I this morning ſaw a terrier bitch repeatedly lick her paws, and waſh her face on both ſides, and over her eyes, exactly as cats do; from whom

whom I ſuppoſe ſhe had acquired this art, as ſhe lived in the parlour with two of them.

Mr. Leonard, a very intelligent friend of mine, ſaw a cat catch a trout by darting upon it in a deep clear water at the mill at Weaford, near Lichfield. The cat belonged to Mr. Stanley, who had often ſeen her catch fiſh in the ſame manner in ſummer, when the mill-pool was drawn ſo low, that the fiſh could be ſeen. I have heard of other cats taking fiſh in ſhallow water, as they ſtood on the bank. This ſeems a natural art of taking their prey in cats, which their acquired delicacy by domeſtication has in general prevented them from uſing, though their deſire of eating fiſh continues in its original ſtrength.

Mr. White, in his ingenious Hiſtory of Selbourn, was witneſs to a cat's ſuckling a young hare, which followed her about the garden, and came jumping to her call of affection. At Elford, near Lichfield, the Rev. Mr. Sawley had taken the young ones out of a hare, which was ſhot; they were alive, and the cat, who had juſt loſt her own kittens, carried them away, as it was ſuppoſed, to eat them; but it preſently appeared, that it was affection not hunger which incited her, as ſhe ſuckled them, and brought them up as their mother.

Other inſtances of the miſtaken application of what has been termed inſtinct may be obſerved in

flies in the night, who miſtaking a candle for day-light, approach and periſh in the flame. So the putrid ſmell of the ſtapelia, or carrion-flower, allures the large fleſh-fly to depoſit its young worms on its beautiful petals, which periſh there for want of nouriſhment. This therefore cannot be a neceſſary inſtinct, becauſe the creature miſtakes the application of it.

Though in this country horſes ſhew little veſtiges of policy, yet in the deſerts of Tartary, and Siberia, when hunted by the Tartars they are ſeen to form a kind of community, ſet watches to prevent their being ſurpriſed, and have commanders, who direct, and haſten their flight, Origin of Language, Vol. I. p. 212. In this country, where four or five horſes travel in a line, the firſt always points his ears forward, and the laſt points his backward, while the intermediate ones ſeem quite careleſs in this reſpect; which ſeems a part of policy to prevent ſurpriſe. As all animals depend moſt on the ear to apprize them of the approach of danger, the eye taking in only half the horizon at once, and horſes poſſeſs a great nicety of this ſenſe; as appears from their mode of fighting mentioned No. 8. 5. of this Section, as well as by common obſervation.

There are ſome parts of a horſe, which he cannot conveniently rub, when they itch, as about the ſhoulder, which he can neither bite with his teeth, nor ſcratch with his hind foot; when this part

part itches, he goes to another horfe, and gently bites him in the part which he wifhes to be bitten, which is immediately done by his intelligent friend. I once obferved a young foal thus bite its large mother, who did not choofe to drop the grafs fhe had in her mouth, and rubbed her nofe againft the foal's neck inftead of biting it; which evinces that fhe knew the defign of her progeny, and was not governed by a neceffary inftinct to bite where fhe was bitten.

Many of our fhrubs, which would otherwife afford an agreeable food to horfes, are armed with thorns or prickles, which fecure them from thofe animals; as the holly, hawthorn, goofeberry, gorfe. In the extenfive moorlands of Stafford-fhire, the horfes have learnt to ftamp upon a gorfe-bufh with one of their forefeet for a minute together, and when the points are broken, they eat it without injury. The horfes in the new foreft in Hampfhire are affirmed to do the fame by Mr. Gilpin. Foreft Scenery, II. 251, and 112. Which is an art other horfes in the fertile parts of the country do not poffefs, and prick their mouths till they bleed, if they are induced by hunger or caprice to attempt eating gorfe.

Swine have a fenfe of touch as well as of fmell at the end of their nofe, which they ufe as a hand, both to root up the foil, and to turn over and examine objects of food, fomewhat like the probofcis of an elephant. As they require fhel-

ter from the cold in this climate, they have learnt to collect ſtraw in their mouths to make their neſt, when the wind blows cold; and to call their companions by repeated cries to aſſiſt in the work, and add to their warmth by their numerous bedfellows. Hence theſe animals, which are eſteemed ſo unclean, have alſo learned never to beſoul their dens, where they have liberty, with their own excrement; an art, which cows and horſes, which have open hovels to run into, have never acquired. I have obſerved great ſagacity in ſwine; but the ſhort lives we allow them, and their general confinement, prevents their improvement, which might probably be otherwiſe greater than that of dogs.

Inſtances of the ſagacity and knowledge of animals are very numerous to every obſerver, and their docility in learning various arts from mankind, evinces that they may learn ſimilar arts from their own ſpecies, and thus be poſſeſſed of much acquired and traditional knowledge.

A dog whoſe natural prey is ſheep, is taught by mankind, not only to leave them unmoleſted, but to guard them; and to hunt, to ſet, or to deſtroy other kinds of animals, as birds, or vermin; and in ſome countries to catch fiſh, in others to find truffles, and to practiſe a great variety of tricks; is it more ſurpriſing that the crows ſhould teach each other, that the hawk can catch leſs birds, by the ſuperior ſwiftneſs of his wing,

wing, and if two of them follow him, till he succeeds in his design, that they can by force share a part of the capture? This I have formerly observed with attention and astonishment.

There is one kind of pelican mentioned by Mr. Osbeck, one of Linnæus's travelling pupils (the pelicanus aquilus), whose food is fish; and which it takes from other birds, because it is not formed to catch them itself; hence it is called by the English a Man-of-war-bird, Voyage to China, p. 88. There are many other interesting anecdotes of the pelican and cormorant, collected from authors of the best authority, in a well-managed Natural History for Children, published by Mr. Galton. Johnson. London.

And the following narration from the very accurate Monf. Adanson, in his voyage to Senegal, may gain credit with the reader: as his employment in this country was solely to make observations in natural history. On the river Niger, in his road to the island Griel, he saw a great number of pelicans, or wide throats. "They moved with great state like swans upon the water, and are the largest bird next to the ostrich; the bill of the one I killed was upwards of a foot and half long, and the bag fastened underneath it held two and twenty pints of water. They swim in flocks, and form a large circle, which they contract afterwards, driving the fish before them with their legs: when they see the fish in sufficient num-

ber confined in this ſpace, they plunge their bill wide open into the water, and ſhut it again with great quickneſs. They thus get fiſh into their throat-bag, which they eat afterwards on ſhore at their leiſure." P. 247.

Another curious effort of deſign, or uſe of means in animals, is related by Abbe Groſier, in his Deſcription of China, Vol. I. p. 562. A kind of tiger is ſeen in China, which has a body like a dog, but no tail, and is remarkably ſwift and ferocious. If any one meets this animal, and to eſcape from his fury climbs up a tree, the tiger immediately ſends forth a loud yell, and ſeveral other tigers arrive; which altogether dig up the earth round the roots of the tree, and overturning it, ſeize their prey.

The rattleſnake and black ſerpent of America alſo ſhould here be mentioned, which are ſuppoſed to poſſeſs an inſtinctive power of faſcinating birds; as many birds have been ſeen repeatedly to run to them and to retreat from them with piteous ſcreams, till the ſnake has ſeized and devoured them. I formerly ſuſpected, that this ſerpent had hid himſelf in the buſhes, and had ſecretly wounded the bird, and followed it with his ſteady eye, till the poiſon inſtilled into the wound had time to take effect; and that the bird then fell from the tree into his mouth. But from an ingenious paper, which Dr. B. S. Barton, Profeſſor of Natural Hiſtory in Pennſylvania, has favoured me with, and which

will

will be publiſhed in their Philoſophical Tranſactions, it is clearly ſhewn, that this piteous cry, and approach, and retreat, of the bird ſuppoſed to be faſcinated is ſimply an attack made by the female bird on the ſerpent in defence of her young; which credulity and the love of admiration has converted into a prodigy of faſcination, which is ſtill credited by the multitude in America. This circumſtance of the mother bird daring to defend her young from a ſerpent, till ſhe was devoured by him, and her ſcreaming around him, is deſcribed by that great obſerver of nature, the immortal Homer, above 2000 years ago. Iliad. Lib. 2. l. 310.

XII. The knowledge and language of thoſe birds, that frequently change their climate with the ſeaſons, is ſtill more extenſive: as they perform theſe migrations in large ſocieties, and are leſs ſubject to the power of man, than the reſident tribes of birds. They are ſaid to follow a leader during the day, who is occaſionally changed, and to keep a continual cry during the night to keep themſelves together. It is probable that theſe emigrations were at firſt undertaken as accident directed, by the more adventurous of their ſpecies, and learned from one another like the diſcoveries of mankind in navigation. The following circumſtances ſtrongly ſupport this opinion.

1. Nature has provided these animals, in the climates where they are produced, with another resource, when the season becomes too cold for their constitutions, or the food they were supported with ceases to be supplied: I mean that of sleeping. Dormice, snakes, and bats, have not the means of changing their country; the two former from the want of wings, and the latter from his being not able to bear the light of the day. Hence these animals are obliged to make use of this resource, and sleep during the winter. And those swallows that have been hatched too late in the year to acquire their full strength of pinion, or that have been maimed by accident or disease, have been frequently found in the hollows of rocks on the sea coasts, and even under water in this torpid state, from which they have been revived by the warmth of a fire. This torpid state of swallows is testified by innumerable evidences both of antient and modern names. Aristotle speaking of the swallows says, "They pass into warmer climates in winter, if such places are at no great distance; if they are, they bury themselves in the climates where they dwell," (8. Hist. c. 16. See also Derham's Phys. Theol. v. ii. p. 177.)

The hybernation of animals is mentioned by M. Fabricius, who supposes it only to happen to animals, which originally belonged to a warmer climate,

climate, and adds, that when these animals are carried back to a warmer climate, and ſupplied plentifully with food, they ceaſe to hybernate.

Hence their emigrations cannot depend on a *neceſſary* inſtinct, as the emigrations themſelves are not *neceſſary*.

2. When the weather becomes cold, the ſwallows in the neighbourhood aſſemble in large flocks; that is, the unexperienced attend thoſe that have before experienced the journey they are about to undertake: they are then ſeen ſome time to hover on the coaſt, till there is calm weather, or a wind, that ſuits the direction of their flight. Other birds of paſſage have been drowned by thouſands in the ſea, or have ſettled on ſhips quite exhauſted with fatigue. And others, either by miſtaking their courſe, or by diſtreſs of weather, have arrived in countries where they were never ſeen before: and thus are evidently ſubject to the ſame hazards that the human ſpecies undergo, in the execution of their artificial purpoſes.

3. The ſame birds are emigrant from ſome countries and not ſo from others: the ſwallows were ſeen at Goree in January by an ingenious philoſopher of my acquaintance, and he was told that they continued there all the year; as the warmth of the climate was at all ſeaſons ſufficient for their own conſtitutions, and for the production of the flies that ſupply them with nouriſhment.

ment. Herodotus ſays, that in Libya, about the ſprings of the Nile, the ſwallows continue all the year. (L. 2.)

Quails (tetrao coturnix, Lin.) are birds of paſſage from the coaſt of Barbary to Italy, and have frequently ſettled in large ſhoals on ſhips fatigued with their flight. (Ray, Wiſdom of God, p. 129. Derham Phyſic. Theol., v. ii. p. 178.) Dr. Ruſſel, in his hiſtory of Aleppo, obſerves that the ſwallows viſit that country about the end of February, and having hatched their young diſappear about the end of July; and returning again about the beginning of October, continue about a fortnight, and then again diſappear. (P. 70.)

When my late friend Dr. Chambres of Derby was on the iſland of Caprea in the bay of Naples, he was informed that great flights of quails annually ſettle on that iſland about the beginning of May, in their paſſage from Africa to Europe. And that they always come when the ſouth-eaſt wind blows, are fatigued when they reſt on this iſland, and are taken in ſuch amazing quantities and ſold to the Continent, that the inhabitants pay the biſhop his ſtipend out of the profits ariſing from the ſale of them.

The flights of theſe birds acroſs the Mediterranean are recorded near three thouſand years ago. "There went forth a wind from the Lord and brought quails from the ſea, and let them

fall

fall upon the camp, a day's journey round about it, and they were two cubits above the earth," (Numbers, chap. ii. ver. 31.)

In our country, Mr. Pennant informs us, that ſome quails migrate, and others only remove from the internal parts of the iſland to the coaſts, (Zoology, octavo, 210.) Some of the ringdoves and ſtares breed here, others migrate, (ibid. 510, 511.) And the ſlender billed ſmall birds do not all quit theſe kingdoms in the winter, though the difficulty of procuring the worms and inſects, that they feed on, ſupplies the ſame reaſon for migration to them all, (ibid. 511.)

Linnæus has obſerved, that in Sweden the female chaffinches quit that country in September, migrating into Holland, and leave their mates behind till their return in ſpring. Hence he has called them Fringilla cælebs, (Amæn. Acad. ii. 42. iv. 595.) Now in our climate both ſexes of them are perennial birds. And Mr. Pennant obſerves that the hoopoe, chatterer, hawfinch, and croſs-bill, migrate into England ſo rarely, and at ſuch uncertain times, as not to deſerve to be ranked among our birds of paſſage, (Zool. 8vo. 511.)

The water fowl, as geeſe and ducks, are better adapted for long migrations, than the other tribes of birds, as, when the weather is calm, they can not only reſt themſelves, or ſleep upon the ocean, but poſſibly procure ſome kind of food from it.

Hence

Hence in Siberia, as ſoon as the lakes are frozen, the water fowl, which are very numerous, all diſappear, and are ſuppoſed to fly to warmer climates, except the rail, which, from its inability for long flights, probably ſleeps, like our bat, in their winter. The following account from the Journey of Profeſſor Gmelin, may entertain the reader. "In the neighbourhood of Kraſnoiark, amongſt many other emigrant water fowls, we obſerved a great number of rails, which when purſued never took flight, but endeavoured to eſcape by running. We inquired how theſe birds, that could not fly, could retire into other countries in the winter, and were told, both by the Tartars and Aſſanians, that they well knew thoſe birds could not alone paſs into other countries: but when the cranes (les grues) retire in autumn, each one takes a rail (un rale) upon his back, and carries him to a warmer climate."

*Recapitulation.*

1. All birds of paſſage can exiſt in the climates, where they are produced.

2. They are ſubject in their migrations to the ſame accidents and difficulties, that mankind are ſubject to in navigation.

3. The ſame ſpecies of birds migrate from ſome countries, and are reſident in others.

From all theſe circumſtances it appears that the

the migrations of birds are not produced by a neceſſary inſtinct, but are accidental improvements, like the arts among mankind, taught by their contemporaries, or delivered by tradition from one generation of them to another.

XIII. In that ſeaſon of the year which ſupplies the nouriſhment proper for the expected brood, the birds enter into a contract of marriage, and with joint labour conſtruct a bed for the reception of their offspring. Their choice of the proper ſeaſon, their contracts of marriage, and the regularity with which they conſtruct their neſts, have in all ages excited the admiration of naturaliſts; and have always been attributed to the power of inſtinct, which, like the occult qualities of the antient philoſophers, prevented all further inquiry. We ſhall conſider them in their order.

*Their Choice of the Seaſon.*

Our domeſtic birds, that are plentifully ſupplied thoughout the year with their adapted food, and are covered with houſes from the inclemency of the weather, lay their eggs at any ſeaſon: which evinces that the ſpring of the year is not pointed out to them by a neceſſary inſtinct.

Whilſt the wild tribes of birds chooſe this time of the year from their acquired knowledge, that the mild temperature of the air is more convenient

venient for hatching their eggs, and is ſoon likely to ſupply that kind of nouriſhment, that is wanted for their young.

If the genial warmth of the ſpring produced the paſſion of love, as it expands the foliage of trees, all other animals ſhould feel its influence as well as birds: but, the viviparous creatures, as they ſuckle their young, that is, as they previouſly digeſt the natural food, that it may better ſuit the tender ſtomachs of their offspring, experience the influence of this paſſion at all ſeaſons of the year, as cats and bitches. The graminivorous animals indeed generally produce their young about the time when graſs is ſupplied in the greateſt plenty, but this is without any degree of exactneſs, as appears from our cows, ſheep, and hares, and may be a part of the traditional knowledge, which they learn from the example of their parents.

*Their Contracts of Marriage.*

Their mutual paſſion, and the acquired knowledge, that their joint labour is neceſſary to procure ſuſtenance for their numerous family, induces the wild birds to enter into a contract of marriage, which does not however take place among the ducks, geeſe, and fowls, that are provided with their daily food from our barns.

An ingenious philoſopher has lately denied,

that animals can enter into contracts, and thinks this an effential difference between them and the human creature:—but does not daily obfervation convince us, that they form contracts of friendfhip with each other, and with mankind? When puppies and kittens play together, is there not a tacit contract, that they will not hurt each other? And does not your favourite dog expect you fhould give him his daily food, for his fervices and attention to you? And thus barters his love for your protection? In the fame manner that all contracts are made amongft men, that do not underftand each others arbitrary language.

*The Conftruction of their Nefts.*

1. They feem to be inftructed how to build their nefts from their obfervation of that, in which they were educated, and from their knowledge of thofe things, that are moft agreeable to their touch in refpect to warmth, cleanlinefs, and ftability. They choofe their fituations from their ideas of fafety from their enemies, and of fhelter from the weather. Nor is the colour of their nefts a circumftance unthought of; the finches, that build in green hedges, cover their habitations with green mofs; the fwallow or martin, that builds againft rocks and houfes, covers hers with clay, whilft the lark choofes vegetable ftraw nearly of the colour of the ground fhe inhabits: by this contrivance,

contrivance, they are all lefs liable to be difcovered by their adverfaries.

2. Nor are the nefts of the fame fpecies of birds conftructed always of the fame materials, nor in the fame form; which is another circumftance that afcertains, that they are led by obfervation.

In the trees before Mr. Levet's houfe in Lichfield, there are annually nefts built by fparrows, a bird which ufually builds under the tiles of houfes, or the thatch of barns. Not finding fuch convenient fituations for their nefts, they build a covered neft bigger than a man's head, with an opening like a mouth at the fide, refembling that of a magpie, except that it is built with ftraw and hay, and lined with feathers, and fo nicely managed as to be a defence againft both wind and rain.

The following extract from a Letter of the Rev. Mr. J. Darwin, of Carleton Scroop in Lincolnfhire, authenticates a curious fact of this kind. "When I mentioned to you the circumftance of crows or rooks building in the fpire of Welbourn church, you expreffed a defire of being well informed of the certainty of the fact. Welbourn is fituated in the road from Grantham to Lincoln on the Cliff row; I yefterday took a ride thither, and inquired of the rector, Mr. Ridgehill, whether the report was true, that rooks built in the fpire of his church. He affured me it was true, and that they had done fo time immemorial,

memorial, as his pariſhioners affirmed. There was a common tradition, he ſaid, that formerly a rookery in ſome high trees adjoined the church yard, which being cut down (probably in the ſpring, the building ſeaſon), the rooks removed to the church, and built their neſts on the outſide of the ſpire on the tops of windows, which by their projection a little from the ſpire made them convenient room, but that they built alſo on the inſide. I ſaw two neſts made with ſticks on the outſide, and in the ſpires, and Mr. Ridgehill ſaid there were always a great many.

"I ſpent the day with Mr. Wright, a clergyman, at Fulbeck, near Welbourn, and in the afternoon Dr. Ellis of Leadenham, about two miles from Welbourn, drank tea at Mr. Wright's, who ſaid he remembered, when Mr. Welby lived at Welbourn, that he received a letter from an acquaintance in the weſt of England, deſiring an anſwer, whether the report of rooks building in Welbourn church was true, as a wager was depending on that ſubject; to which he returned an anſwer aſcertaining the fact, and decided the wager." Aug. 30, 1794.

So the jackdaw (corvus monedula) generally builds in church ſteeples, or under the roofs of high houſes; but at Selbourn, in Southamptonſhire, where towers and ſteeples are not ſufficiently numerous, theſe birds build in forſaken rabbit

burrows. See a curious account of theſe ſubterranean neſts in White's Hiſtory of Selbourn, p. 59. Can the ſkilful change of architecture in theſe birds and the ſparrows above mentioned be governed by inſtinct? Then they muſt have two inſtincts, one for common, and the other for extraordinary occaſions.

I have ſeen green worſted in a neſt, which no where exiſts in nature: and the down of thiſtles in thoſe neſts, that were by ſome accident conſtructed later in the ſummer, which material could not be procured for the earlier neſts: in many different climates they cannot procure the ſame materials, that they uſe in ours. And it is well known, that the canary birds, that are propagated in this country, and the finches, that are kept tame, will build their neſts of any flexile materials, that are given them. Plutarch, in his Book on Rivers, ſpeaking of the Nile, ſays, "that the ſwallows collect a material, when the waters recede, with which they form neſts, that are impervious to water." And in India there is a ſwallow that collects a glutinous ſubſtance for this purpoſe, whoſe neſt is eſculent, and eſteemed a principal rarity amongſt epicures, (Lin. Syſt. Nat.) Both theſe muſt be conſtructed of very different materials from thoſe uſed by the ſwallows of our country.

In India the birds exert more artifice in building their neſts on account of the monkeys and

ſnakes:

ſnakes: ſome form their penſile neſts in the ſhape of a purſe, deep and open at top; others with a hole in the ſide; and others, ſtill more cautious, with an entrance at the very bottom, forming their lodge near the ſummit. But the taylor-bird will not even truſt its neſt to the extremity of a tender twig, but makes one more advance to ſafety by fixing it to the leaf itſelf. It picks up a dead leaf, and ſews it to the ſide of a living one, its ſlender bill being its needle, and its thread ſome fine fibres; the lining conſiſts of feathers, goſſamer, and down; its eggs are white, the colour of the bird light yellow, its length three inches, its weight three ſixteenths of an ounce; ſo that the materials of the neſt, and the weight of the bird, are not likely to draw down an habitation ſo ſlightly ſuſpended. A neſt of this bird is preſerved in the Britiſh Muſeum, (Pennant's Indian Zoology). This calls to one's mind the Moſaic account of the origin of mankind, the firſt dawning of art there aſcribed to them, is that of ſewing leaves together. For many other curious kinds of neſts ſee Natural Hiſtory for Children, by Mr. Galton. Johnſon. London. Part I. p. 47. Gen. Oriolus.

3. Thoſe birds that are brought up by our care, and have had little communication with others of their own ſpecies, are very defective in this acquired knowledge; they are not only very awkward in the conſtruction of their neſts, but

generally ſcatter their eggs in various parts of the room or cage, where they are confined, and ſeldom produce young ones, till, by failing in their firſt attempt, they have learnt ſomething from their own obſervation.

4. During the time of incubation birds are ſaid in general to turn their eggs every day; ſome cover them, when they leave the neſt, as ducks and geeſe; in ſome the male is ſaid to bring food to the female, that ſhe may have leſs occaſion of abſence, in others he is ſaid to take her place, when ſhe goes in queſt of food; and all of them are ſaid to leave their eggs a ſhorter time in cold weather than in warm. In Senegal the oſtrich ſits on her eggs only during the night, leaving them in the day to the heat of the ſun; but at the Cape of Good Hope, where the heat is leſs, ſhe ſits on them day and night.

If it ſhould be aſked, what induces a bird to ſit weeks on its firſt eggs unconſcious that a brood of young ones will be the product? The anſwer muſt be, that it is the ſame paſſion that induces the human mother to hold her offspring whole nights and days in her fond arms, and preſs it to her boſom, unconſcious of its future growth to ſenſe and manhood, till obſervation or tradition have informed her.

5. And as many ladies are too refined to nurſe their own children, and deliver them to the care and proviſion of others; ſo is there one inſtance of

of this vice in the feathered world. The cuckoo in ſome parts of England, as I am well informed by a very diſtinct and ingenious gentleman, hatches and educates her young; whilſt in other parts ſhe builds no neſt, but uſes that of ſome leſſer bird, generally either of the wagtail, or hedge ſparrow, and depoſiting one egg in it, takes no further care of her progeny.

M. Heriſſant thought, that he had diſcovered the reaſon, why cuckoos do not incubate their own eggs, by having obſerved that the crop or ſtomach of the cuckoo was placed behind the ſternum, or breaſt-bone, and he thence fancied, that this would render incubation diſagreeable or impracticable. Hiſt. de l' Acad. Royal. 1752. But Mr. White, in his Natural Hiſtory of Selbourn aſſerts, that on diſſecting a fern-owl he found the ſituation of the crop or ſtomach of that bird to be behind the ſternum, like that of the cuckoo, and ſuppoſes that many other birds may be organized in the ſame manner. And, as the fern owl incubates and hatches her own eggs, he rationally concludes, that this ſtructure of the bird cannot be the cauſe of her want of maternal ſtorge. Hiſt. of Selbourn, p. 208.

As the Rev. Mr. Stafford was walking in Gloſop Dale, in the Peak of Derbyſhire, he ſaw a cuckoo riſe from its neſt. The neſt was on the ſtump of a tree, that had been ſome time felled, among ſome chips that were in part turned

grey, fo as much to refemble the colour of the bird; in this neft were two young cuckoos: tying a ftring about the leg of one of them, he pegged the other end of it to the ground, and very frequently for many days beheld the old cuckoo feed thefe young, as he ftood very near them.

The following extract of a Letter from the Rev. Mr. Wilmot, of Morley, near Derby, ftrengthens the truth of the fact above mentioned, of the cuckoo fometimes making a neft, and hatching her own young.

"In the beginning of July 1792, I was attending fome labourers on my farm, when one of them faid to me, "There is a bird's neft upon one of the Coal-flack Hills; the bird is now fitting, and is exactly like a cuckoo. They fay that cuckoos never hatch their own eggs, otherwife I fhould have fworn it was one." He took me to the fpot, it was in an open fallow ground; the bird was upon the neft, I ftood and obferved her fome time, and was perfectly fatisfied it was a cuckoo; I then put my hand towards her, and fhe almoft let me touch her before fhe rofe from the neft, which fhe appeared to quit with great uneafinefs, fkimming over the ground in the manner that a hen partridge does when difturbed from a new hatched brood, and went only to a thicket about forty or fifty yards from the neft; and continued there as long as I ftaid to obferve her, which was not many minutes. In the neft, which

which was barely a hole ſcratched out of the coal ſlack in the manner of a plover's neſt, I obſerved three eggs, but did not touch them. As I had labourers conſtantly at work in that field, I went thither every day, and always looked to ſee if the bird was there, but did not diſturb her for ſeven or eight days, when I was tempted to drive her from the neſt, and found *two* young ones, that appeared to have been hatched ſome days, but there was no appearance of the third egg. I then mentioned this extraordinary circumſtance (for ſuch I thought it) to Mr. and Mrs. Holyoak of Bidford Grange, Warwickſhire, and to Miſs M. Willes, who were on a viſit at my houſe, and who all went to ſee it. Very lately I reminded Mr. Holyoak of it, who told me he had a perfect recollection of the whole, and that, conſidering it a curioſity, he walked to look at it ſeveral times, was perfectly ſatisfied as to its being a cuckoo, and thought her more attentive to her young, than any other bird he ever obſerved, having always found her brooding her young. In about a week after I firſt ſaw the young ones, one of them was miſſing, and I rather ſuſpected my plough-boys having taken it; though it might poſſibly have been taken by a hawk, ſometime when the old one was ſeeking food. I never found her off her neſt but once, and that was the laſt time I ſaw the remaining young one, when it was almoſt full feathered. I then went from

home for two or three days, and, when I returned, the young one was gone, which I take for granted had flown. Though during this time I frequently ſaw cuckoos in the thicket I mention, I never obſerved any one, that I ſuppoſed to be the cock-bird, paired with this hen."

Nor is this a new obſervation, though it is entirely overlooked by the modern naturaliſts, for Ariſtotle ſpeaking of the cuckoo, aſſerts that ſhe ſometimes builds her neſt among broken rocks, and on high mountains, (L. 6. H. c. 1.) but adds in another place that ſhe generally poſſeſſes the neſt of another bird, (L. 6. H. c. 7.) And Niphus ſays that cuckoos rarely build for themſelves, moſt frequently laying their eggs in the neſts of other birds, (Geſner, L. 3. de Cuculo.)

The Philoſopher who is acquainted with theſe facts concerning the cuckoo, would ſeem to have very little *reaſon* himſelf, if he could imagine this neglect of her young to be a neceſſary *inſtinct!*

XIV. The deep receſſes of the ocean are inacceſſible to mankind, which prevents us from having much knowledge of the arts and government of its inhabitants.

1. One of the baits uſed by the fiſherman is an animal called an Old Soldier; his ſize and form are ſomewhat like the craw-fiſh, with this difference, that his tail is covered with a tough membrane inſtead of a ſhell; and to obviate this defect, he ſeeks out the uninhabited ſhell of ſome

dead

dead fiſh, that is large enough to receive his tail, and carries it about with him as part of his clothing or armour.

2. On the coaſts about Scarborough, where the haddocks, cods, and dog-fiſh, are in great abundance, the fiſhermen univerſally believe that the dog-fiſh make a line, or ſemicircle, to encompaſs a ſhoal of haddocks and cod, confining them within certain limits near the ſhore, and eating them as occaſion requires. For the haddocks and cod are always found near the ſhore without any dog-fiſh among them, and the dog-fiſh further off without any haddocks or cod; and yet the former are known to prey upon the latter, and in ſome years devour ſuch immenſe quantities as to render this fiſhery more expenſive than profitable.

3. The remora, when he wiſhes to remove his ſituation, as he is a very ſlow ſwimmer, is content to take an outſide place on whatever conveyance is going his way; nor can the cunning animal be tempted to quit his hold of a ſhip when ſhe is ſailing, not even for the lucre of a piece of pork, leſt it ſhould endanger the loſs of his paſſage: at other times he is eaſily caught with the hook.

4. The crab-fiſh, like many other teſtaceous animals, annually changes its ſhell; it is then in a ſoft ſtate, covered only with a mucous membrane, and conceals itſelf in holes in the ſand or under weeds; at this place a hard ſhelled crab always ſtands centinel, to prevent the ſea inſects

from

from injuring the other in its defenceless ſtate; and the fiſhermen from his appearance know where to find the ſoft ones, which they uſe for baits in catching other fiſh.

And though the hard ſhelled crab, when he is on this duty, advances boldly to meet the foe, and will with difficulty quit the field; yet at other times he ſhews great timidity, and has a wonderful ſpeed in attempting his eſcape; and, if often interrupted, will pretend death like the ſpider, and watch an opportunity to ſink himſelf into the ſand, keeping only his eyes above. My ingenious friend Mr. Burdett, who favoured me with theſe accounts at the time he was ſurveying the coaſts, thinks the commerce between the ſexes takes place at this time, and inſpires the courage of the creature.

5. The ſhoals of herrings, cods, haddocks, and other fiſh, which approach our ſhores at certain ſeaſons, and quit them at other ſeaſons without leaving one behind; and the ſalmon, that periodically frequent our rivers, evince, that there are vagrant tribes of fiſh, that perform as regular migrations as the birds of paſſage already mentioned.

6. There is a cataract on the river Liffey in Ireland about nineteen feet high: here in the ſalmon ſeaſon many of the inhabitants amuſe themſelves in obſerving theſe fiſh leap up the torrent. They dart themſelves quite out of the

water

water as, they afcend, and frequently fall back many times before they furmount it, and bafkets made of twigs are placed near the edge of the ftream to catch them in their fall.

I have obferved, as I have fat by a fpout of water, which defcends from a ftone trough about two feet into a ftream below, at particular feafons of the year, a great number of little fifh called minums, or pinks, throw themfelves about twenty times their own length out of the water, expect-ing to get into the trough above.

This evinces that the ftorge, or attention of the dam to provide for the offspring, is ftrongly exerted amongft the nations of fifh, where it would feem to be the moft neglected; as thefe falmon cannot be fuppofed to attempt fo difficult and dangerous a tafk without being confcious of the purpofe or end of their endeavours.

It is further remarkable, that moft of the old falmon return to the fea before it is proper for the young fhoals to attend them, yet that a few old ones continue in the rivers fo late, that they become perfectly emaciated by the inconvenience of their fituation, and this apparently to guide or to pro-tect the unexperienced brood.

Of the fmaller water animals we have ftill lefs knowledge, who neverthelefs probably poffefs many fuperior arts; fome of thefe are mentioned in Botanic Garden, P. I. Add. Note XXVII. and XXVIII. The nymphæ of the water-moths of our

our rivers, which cover themſelves with caſes of ſtraw, gravel, and ſhell, contrive to make their habitations nearly in equilibrium with the water; when too heavy, they add a bit of wood or ſtraw; when too light, a bit of gravel. Edinb. Tranſ.

All theſe circumſtances bear a near reſemblance to the deliberate actions of human reaſon.

XV. We have a very imperfect acquaintance with the various tribes of inſects: their occupations, manner of life, and even the number of their ſenſes, differ from our own, and from each other; but there is reaſon to imagine, that thoſe which poſſeſs the ſenſe of touch in the moſt exquiſite degree, and whoſe occupations require the moſt conſtant exertion of their powers, are induced with a greater proportion or knowledge and ingenuity.

The ſpiders of this country manufacture neſts of various forms, adapted to various ſituations, to arreſt the flies that are their food; and ſome of them have a houſe or lodging-place in the middle of the net, well contrived for warmth, ſecurity, or concealment. There is a large ſpider in South America, who conſtructs nets of ſo ſtrong a texture as to entangle ſmall birds, particularly the humming bird. And in Jamaica there is another ſpider, who digs a hole in the earth obliquely downwards, about three inches in length, and one inch in diameter; this cavity ſhe lines with a tough thick web, which when taken out reſembles

bles a leathern purſe: but what is moſt curious, this houſe has a door with hinges, like the operculum of ſome ſea ſhells; and herſelf and family, who tenant this neſt, open and ſhut the door, whenever they paſs or repaſs. This hiſtory was told me, and the neſt with its operculum ſhewn me by the late Dr. Butt of Bath, who was ſome years phyſician in Jamaica.

The production of theſe nets is indeed a part of the nature or conformation of the animal, and their natural uſe is to ſupply the place of wings, when ſhe wiſhes to remove to another ſituation. But when ſhe employs them to entangle her prey, there are marks of evident deſign, for ſhe adapts the form of each net to its ſituation, and ſtrengthens thoſe lines, that require it, by joining others to the middle of them, and attaching thoſe others to diſtant objects, with the ſame individual art, that is uſed by mankind in ſupporting the maſts and extending the ſails of ſhips. This work is executed with more mathematical exactneſs and ingenuity by the field ſpiders, than by thoſe in our houſes, as their conſtructions are more ſubjected to the injuries of dews and tempeſts.

Beſides the ingenuity ſhewn by theſe little creatures in taking their prey, the circumſtance of their counterfeiting death, when they are put into terror, is truly wonderful; and as ſoon as the object of terror is removed, they recover and

run

run away. Some beetles are alfo faid to poffefs this piece of hypocrify.

The curious webs, or cords, conftructed by fome young caterpillars to defend themfelves from cold, or from infects of prey; and by filk-worms and fome other caterpillars, when they tranfmigrate into aureliæ or larvæ, have defervedly excited the admiration of the inquifitive. But our ignorance of their manner of life, and even of the number of their fenfes, totally precludes us from underftanding the means by which they acquire this knowledge.

The care of the falmon in choofing a proper fituation for her fpawn, the ftructure of the nefts of birds, their patient incubation, and the art of the cuckoo in depofiting her egg in her neighbour's nurfery, are inftances of great fagacity in thofe creatures: and yet they are much inferior to the arts exerted by many of the infect tribes on fimilar occafions. The hairy excrefcences on briars, the oak apples, the blafted leaves of trees, and the lumps on the backs of cows, are fituations that are rather produced than chofen by the mother infect for the convenience of her offspring. The cells of bees, wafps, fpiders, and of the various coralline infects, equally aftonifh us, whether we attend to the materials or to the architecture.

But the conduct of the ant, and of fome fpecies of the ichneumon fly in the incubation of their eggs, is equal to any exertion of human fcience.

The

The ants many times in a day move their eggs nearer the furface of their habitation, or deeper below it, as the heat of the weather varies; and in colder days lie upon them in heaps for the purpofe of incubation: if their manfion is too dry, they carry them to places where there is moifture, and you may diftinctly fee the little worms move and fuck up the water. When too much moifture approaches their neft, they convey their eggs deeper in the earth, or to fome other place of fafety. (Swammerd. Epil. ad Hift. Infect. p. 153. Phil. Tranf. No. 23. Lowthorp. V. 2. p. 7.)

There is one fpecies of ichneumon-fly, that digs a hole in the earth, and carrying into it two or three living caterpillars, depofits her eggs, and nicely clofing up the neft leaves them there; partly doubtlefs to affift the incubation, and partly to fupply food to her future young, (Derham. B. 4. c. 13. Ariftotle Hift. Animal. L. 5. c. 20.)

A friend of mine put about fifty large caterpillars collected from cabbages on fome bran and a few leaves into a box, and covered it with gauze to prevent their efcape. After a few days we faw, from more than three fourths of them, about eight or ten little caterpillars of the ichneumon-fly come out of their backs, and fpin each a fmall cocoon of filk, and in a few days the large caterpillars died. This fmall fly it feems

lays

lays its egg in the back of the cabbage caterpillar, which when hatched preys upon the material, which is produced there for the purpofe of making filk for the future neft of the cabbage caterpillar; of which being deprived, the creature wanders about till it dies, and thus our gardens are preferved by the ingenuity of this cruel fly.

This curious property of producing a filk thread, which is common to fome fea animals, fee Botanic Garden, Part I. Note XXVII. and is defigned for the purpofe of their transformation as in the filkworm, is ufed for conveying themfelves from higher branches to lower ones of trees by fome caterpillars, and to make themfelves temporary nefts or tents, and by the fpider for entangling his prey. Nor is it ftrange that fo much knowledge fhould be acquired by fuch fmall animals; fince there is reafon to imagine, that thefe infects have the fenfe of touch, either in their probofcis, or their antennæ, to a great degree of perfection; and thence may poffefs, as far as their fphere extends, as accurate knowledge, and as fubtle invention, as the difcoverers of human arts.

XVI. 1. If we were better acquainted with the hiftories of thofe infects that are formed into focieties, as the bees, wafps, and ants, I make no doubt but we fhould find, that their arts and improvements are not fo fimilar and uniform as they now appear to us, but that they arofe in the fame manner from experience and tradition, as the arts

of

of our own ſpecies; though their reaſoning is from fewer ideas, is buſied about fewer objects, and is exerted with leſs energy.

There are ſome kinds of inſects that migrate like the birds before mentioned. The locuſt of warmer climates has ſometimes come over to England; it is ſhaped like a graſshopper, with very large wings, and a body above an inch in length. It is mentioned as coming into Egypt with an eaſt wind, "The Lord brought an eaſt wind upon the land all that day and night, and in the morning the eaſt wind brought the locuſts, and covered the face of the earth, ſo that the land was dark," Exod. x. 13. The migrations of theſe inſects are mentioned in another part of the ſcripture, "The locuſts have no king, yet go they forth all of them in bands," Prov. xxx. 27.

The accurate Mr. Adanſon, near the river Gambia in Africa, was witneſs to the migration of theſe inſects. "About eight in the morning, in the month of February, there ſuddenly aroſe over our heads a thick cloud, which darkened the air, and deprived us of the rays of the ſun. We found it was a cloud of locuſts raiſed about twenty or thirty fathoms from the ground, and covering an extent of ſeveral leagues; at length a ſhower of theſe inſects deſcended, and after devouring every green herb, while they reſted, again reſumed their flight. This cloud was brought by a ſtrong eaſt-wind, and was all the morning in

paſſing over the adjacent country." (Voyage to Senegal, 158.)

In this country the gnats are ſometimes ſeen to migrate in clouds, like the muſketoes of warmer climates, and our ſwarms of bees frequently travel many miles, and are ſaid in North America always to fly toward the ſouth. The prophet Iſaiah has a beautiful alluſion to theſe migrations, "The Lord ſhall call the fly from the rivers of Egypt, and ſhall hiſs for the bee that is in the land of Aſſyria," Iſa. vii. 18. which has been lately explained by Mr. Bruce, in his Travels to diſcover the Source of the Nile.

2. I am well informed that the bees that were carried into Barbadoes, and other weſtern iſlands, ceaſed to lay up any honey after the firſt year, as they found it not uſeful to them: and are now become very troubleſome to the inhabitants of thoſe iſlands by infeſting their ſugar-houſes; but thoſe in Jamaica continue to make honey, as the cold north winds, or rainy ſeaſons of that iſland, confine them at home for ſeveral weeks together. And the bees of Senegal, which differ from thoſe of Europe only in ſize, make their honey not only ſuperior to ours in delicacy of flavour, but it has this ſingularity, that it never concretes, but remains liquid as ſyrup, (Adanſon). From ſome obſervations of Mr. Wildman, and of other people of veracity, it appears, that during the ſevere part of the winter ſeaſon for weeks together the bees

are

are quite benumbed and torpid from the cold, and do not consume any of their provision. This state of sleep, like that of swallows and bats, seems to be the natural resource of those creatures in cold climates, and the making of honey to be an artificial improvement.

As the death of our hives of bees appears to be owing to their being kept so warm, as to require food when their stock is exhausted; a very observing gentleman at my request put two hives for many weeks into a dry cellar, and observed, during all that time, they did not consume any of their provision, for their weight did not decrease as it had done when they were kept in the open air. The same observation is made in the Annual Register for 1768, p. 113. And the Rev. Mr. White, in his Method of preserving Bees, adds, that those on the north side of his house consumed less honey in the winter than those on the south side.

There is another observation on bees well ascertained, that they at various times, when the season begins to be cold, by a general motion of their legs as they hang in clusters produce a degree of warmth, which is easily perceptible by the hand. Hence by this ingenious exertion, they for a long time prevent the torpid state they would naturally fall into.

According to the late observations of Mr. Hunter, it appears that the bee's-wax is not made

from the duſt of the anthers of flowers, which they bring home on their thighs, but that this makes what is termed bee-bread, and is uſed for the purpoſe of feeding the bee maggots; in the ſame manner butterflies live on honey, but the previous caterpillar lives on vegetable leaves, while the maggots of large flies require fleſh for their food, and thoſe of the ichneumon fly require inſects for their food. What induces the bee who lives on honey to lay up vegetable powder for its young? What induces the butterfly to lay its eggs on leaves, when itſelf feeds on honey? What induces the other flies to ſeek a food for their progeny different from what they conſume themſelves? If theſe are not deductions from their own previous experience or obſervation, all the actions of mankind muſt be reſolved into inſtinct.

3. "The dormouſe conſumes but little of its food during the rigour of the ſeaſon, for they roll themſelves up, or ſleep, or lie torpid the greateſt part of the time; but on warm ſunny days experience a ſhort revival, and take a little food, and then relapſe into their former ſtate." (Pennant Zoolog. p. 67.) Other animals that ſleep in winter without laying up any provender, are obſerved to go into their winter beds fat and ſtrong, but return to day light in the ſpring ſeaſon very lean and feeble. The common flies ſleep during the winter without any proviſion for their nouriſhment, and are daily revived by the warmth of the



ſun,

ſun, or of our fires. Theſe whenever they ſee light endeavour to approach it, having obſerved, that by its greater vicinity they get free from the degree of torpor, that the cold produces; and are hence induced perpetually to burn themſelves in our candles: deceived, like mankind, by the miſapplication of their knowledge. Whilſt many of the ſubterraneous inſects, as the common worms, ſeem to retreat ſo deep into the earth as not to be enlivened or awakened by the difference of our winter days; and ſtop up their holes with leaves or ſtraws, to prevent the froſts from injuring them,* or the centipes from devouring them. The habits of peace, or the ſtratagems of war, of theſe ſubterranean nations are covered from our view; but a friend of mine prevailed on a diſtreſſed worm to enter the hole of another worm on a bowling-green, and he preſently returned much wounded about his head. And I once ſaw a worm riſe haſtily out of the earth into the ſunſhine, and obſerved a centipes hanging at its tail: the centipes nimbly quitted the tail, and ſeizing the worm about its middle cut it in half with its forceps, and preyed upon one part, while the other eſcaped. Which evinces they have deſign in ſtopping the mouths of their habitations.

4. The waſp of this country fixes his habitation under ground, that he may not be affected with the various changes of our climate; but in Jamaica* he hangs it on the bough of a tree, where the ſeaſons

are lefs fevere. He weaves a very curious paper of vegetable fibres to cover his neft, which is conftructed on the fame principle with that of the bee, but with a different material; but as his prey confifts of flefh, fruits, and infects, which are perifhable commodities, he can lay up no provender for the winter.

M. de la Loubiere, in his relation of Siam, fays, "That in a part of that kingdom, which lies open to great inundations, all the ants make their fettlements upon trees; no ants' nefts are to be feen any where elfe." Whereas in our country the ground is their only fituation. From the fcriptural account of thefe infects, one might be led to fufpect, that in fome climates they lay up a provifion for the winter, (Prov. vi. 6. xxx. 25.) Origen affirms the fame, (Cont. Celf. L. 4.) But it is generally believed that in this country they do not. The white ants of the coaft of Africa make themfelves pyramids eight or ten feet high, on a bafe of about the fame width, with a fmooth furface of rich clay, exceffively hard and well built, which appear at a diftance like an affemblage of the huts of the negroes, (Adanfon). The hiftory of thefe has been lately well defcribed in the Philofoph. Tranfactions, under the name of termes, or termites. Thefe differ very much from the neft of our large ant; but the real hiftory of this creature, as well as of the wafp, is yet very imperfectly known.

Waſps are ſaid to catch large ſpiders, and to cut off their legs, and carry their mutilated bodies to their young, Dict. Raiſon. Tom. I. p. 152.

One circumſtance I ſhall relate which fell under my own eye, and ſhewed the power of reaſon in a waſp, as it is exerciſed among men. A waſp, on a gravel walk, had caught a fly nearly as large as himſelf; kneeling on the ground I obſerved him ſeparate the tail and the head from the body part, to which the wings were attached. He then took the body part in his paws, and roſe about two feet from the ground with it; but a gentle breeze wafting the wings of the fly turned him round in the air, and he ſettled again with his prey upon the gravel. I then diſtinctly obſerved him cut off with his mouth, firſt one of the wings, and then the other, after which he flew away with it unmoleſted by the wind.

Go, thou ſluggard, learn arts and induſtry from the bee, and from the ant!

Go, proud reaſoner, and call the worm thy ſiſter!

## XVII. *Concluſion.*

It was before obſerved how much the ſuperior accuracy of our ſenſe of touch contributes to increaſe our knowledge; but it is the greater energy and activity of the power of volition (as explained in the former Sections of this work) that

marks man, and has given him the empire of the world.

There is a criterion by which we may diſtinguiſh our voluntary acts or thoughts from thoſe that are excited by our ſenſations; "The former are always employed about the *means* to acquire pleaſureable objects, or to avoid painful ones: while the latter are employed about the *poſſeſſion* of thoſe that are already in our power."

If we turn our eyes upon the fabric of our fellow animals, we find they are ſupported with bones, covered with ſkins, moved by muſcles; that they poſſeſs the ſame ſenſes, acknowledge the ſame appetites, and are nouriſhed by the ſame aliment with ourſelves; and we ſhould hence conclude from the ſtrongeſt analogy, that their internal faculties were alſo in ſome meaſure ſimilar to our own.

Mr. Locke indeed publiſhed an opinion, that other animals poſſeſſed no abſtract or general ideas, and thought this circumſtance was the barrier between the brute and the human world. But theſe abſtracted ideas have been ſince demonſtrated by Biſhop Berkeley, and allowed by Mr. Hume, to have no exiſtence in nature, not even in the mind of their inventor, and we are hence neceſſitated to look for ſome other mark of diſtinction.

The ideas and actions of brutes, like thoſe of children, are almoſt perpetually produced by their preſent

present pleasures, or their present pains; and, except in the few instances that have been mentioned in this Section, they seldom busy themselves about the *means* of procuring future bliss, or avoiding future misery.

Whilst the acquiring of languages, the making of tools, and the labouring for money; which are all only the *means* of procuring pleasure; and the praying to the Deity, as another *means* to procure happiness, are characteristic of human nature.

## SECT. XVII.

### THE CATENATION OF MOTIONS.

I. 1. *Catenations of animal motion.* 2. *Are produced by irritations, by ſenſations, by volitions.* 3. *They continue ſome time after they have been excited. Cauſe of catenation.* 4. *We can then exert our attention on other objects.* 5. *Many catenations of motions go on together.* 6. *Some links of the catenations of motions may be left out without diſuniting the chain.* 7. *Interrupted circles of motion continue confuſedly till they come to the part of the circle, where they were diſturbed.* 8. *Weaker catenations are diſſevered by ſtronger.* 9. *Then new catenations take place.* 10. *Much effort prevents their reuniting. Impediment of ſpeech.* 11. *Trains more eaſily diſſevered than circles.* 12. *Sleep deſtroys volition and external ſtimulus.* II. *Inſtances of various catenations in a young lady playing on the harpſichord.* III. 1. *What catenations are the ſtrongeſt.* 2. *Irritations joined with aſſociations from ſtrongeſt connexions. Vital motions.* 3. *New links with increaſed force, cold fits of fever produced.* 4. *New links with decreaſed force. Cold bath.* 5. *Irritation joined with ſenſation. Inflammatory fever. Why children cannot tickle themſelves.* 6. *Volition joined with ſenſation. Irritative ideas of ſound become ſenſible.* 7. *Ideas of imagination diſſevered by irritations, by volition, production of ſurpriſe.*

I. 1. To inveſtigate with preciſion the catenations of animal motions, it would be well to attend

attend to the manner of their production; but we cannot begin this disquisition early enough for this purpose, as the catenations of motion seem to begin with life, and are only extinguishable with it. We have spoken of the power of irritation, of sensation, of volition, and of association, as preceding the fibrous motions; we now step forwards, and consider, that conversely they are in their turn preceded by those motions; and that all the successive trains or circles of our actions are composed of this twofold concatenation. Those we shall call trains of action, which continue to proceed without any stated repetitions; and those circles of action, when the parts of them return at certain periods, though the trains, of which they consist, are not exactly similar. The reading an epic poem is a train of actions; the reading a song with a chorus at equal distances in the measure constitutes so many circles of action.

2. Some catenations of animal motion are produced by reiterated successive irritations, as when we learn to repeat the alphabet in its order by frequently reading the letters of it. Thus the vermicular motions of the bowels were originally produced by the successive irritations of the passing aliment; and the succession of actions of the auricles and ventricles of the heart was originally formed by successive stimulus of the blood, these afterwards become part of the diurnal circles of animal actions, as appears by the periodical re-

turns

turns of hunger, and the quickened pulſe of weak people in the evening.

Other catenations of animal motion are gradually acquired by ſucceſſive agreeable ſenſations, as in learning a favourite ſong or dance; others by diſagreeable ſenſations, as in coughing or nictitation; theſe become aſſociated by frequent repetition, and afterwards compoſe parts of greater circles of action like thoſe above mentioned.

Other catenations of motions are gradually acquired by frequent voluntary repetitions; as when we deliberately learn to march, read, fence, or any mechanic art, the motions of many of our muſcles become gradually linked together in trains, tribes, or circles of action. Thus when any one at firſt begins to uſe the tools in turning wood or metals in a lathe, he wills the motions of his hand or fingers, till at length theſe actions become ſo connected with the effect, that he ſeems only to will the point of the chiſſel. Theſe are cauſed by volition, connected by aſſociation like thoſe above deſcribed, and afterwards become parts of our diurnal trains or circles of action.

3. All theſe catenations of animal motions are liable to proceed ſome time after they are excited, unleſs they are diſturbed or impeded by other irritations, ſenſations, or volitions; and in many inſtances in ſpite of our endeavours to ſtop them; and this property of animal motions is probably the cauſe of their catenation. Thus

when

when a child revolves ſome minutes on one foot, the ſpectra of the ambient objects appear to circulate round him ſome time after he falls upon the ground. Thus the palpitation of the heart continues ſome time after the object of fear, which occaſioned it, is removed. The bluſh of ſhame, which is an exceſs of ſenſation, and the glow of anger, which is an exceſs of volition, continue ſome time, though the affected perſon finds, that thoſe emotions were cauſed by miſtaken facts, and endeavours to extinguiſh their appearance. See Sect. XII. 1. 5.

4. When a circle of motions becomes connected by frequent repetitions as above, we can exert our attention ſtrongly on other objects, and the concatenated circle of motions will nevertheleſs proceed in due order; as whilſt you are thinking on this ſubject, you uſe variety of muſcles in walking about your parlour, or in ſitting at your writing-table.

5. Innumerable catenations of motions may proceed at the ſame time, without incommoding each other. Of theſe are the motions of the heart and arteries; thoſe of digeſtion and glandular ſecretion; of the ideas, or ſenſual motions; thoſe of progreſſion, and of ſpeaking; the great annual circle of actions ſo apparent in birds in their times of breeding and moulting; the monthly circles of many female animals; and the diurnal circles of ſleeping and waking, of fulneſs and inanition.

6. Some links of fucceffive trains or of fynchronous tribes of action may be left out without disjoining the whole. Such are our ufual trains of recollection; after having travelled through an entertaining country, and viewed many delightful lawns, rolling rivers, and echoing rocks; in the recollection of our journey we leave out the many diftricts, that we croffed, which were marked with no peculiar pleafure. Such alfo are our complex ideas, they are catenated tribes of ideas, which do not perfectly refemble their correfpondent perceptions, becaufe fome of the parts are omitted.

7. If an interrupted circle of actions is not entirely differvered, it will continue to proceed confufedly, till it comes to the part of the circle, where it was interrupted.

The vital motions in a fever from drunkennefs, and in other periodical difeafes, are inftances of this circumftance. The accidental inebriate does not recover himfelf perfectly till about the fame hour on the fucceeding day. The accuftomed drunkard is difordered, if he has not his ufual potation of fermented liquor. So if a confiderable part of a connected tribe of action be difturbed, that whole tribe goes on with confufion, till the part of the tribe affected regains its accuftomed catenations. So vertigo produces vomiting, and a great fecretion of bile, as in fea-fick-

nefs,

nefs, all thefe being parts of the tribe of irritative catenations.

8. Weaker catenated trains may be diffevered by the fudden exertion of the ftronger. When a child firft attempts to walk acrofs a room, call to him, and he inftantly falls upon the ground. So while I am thinking over the virtues of my friends, if the tea-kettle fpurt out fome hot water on my ftocking; the fudden pain breaks the weaker chain of ideas, and introduces a new group of figures of its own. This circumftance is extended to fome unnatural trains of action, which have not been confirmed by long habit; as the hiccough, or an ague-fit, which are frequently curable by furprife. A young lady about eleven years old had for five days had a contraction of one mufcle in her fore arm, and another in her arm, which occurred four or five times every minute; the mufcles were feen to leap, but without bending the arm. To counteract this new morbid habit, an iffue was placed over the convulfed mufcle of her arm, and an adhefive plafter wrapped tight like a bandage over the whole fore arm, by which the new motions were immediately deftroyed, but the means were continued fome weeks to prevent a return.

9. If any circle of actions is diffevered, either by omiffion of fome of the links, as in fleep, or by infertion of other links, as in furprife, new catenations take place in a greater or lefs degree. The

laft

laſt link of the broken chain of actions becomes connected with the new motion which has broken it, or with that which was neareſt the link omitted; and theſe new catenations proceed inſtead of the old ones. Hence the periodic returns of ague-fits, and the chimeras of our dreams.

10. If a train of actions is diſſevered, much effort of volition or ſenſation will prevent its being reſtored. Thus in the common impediment of ſpeech, when the aſſociation of the motions of the muſcles of enunciation with the idea of the word to be ſpoken is diſordered, the great voluntary efforts, which diſtort the countenance, prevent the rejoining of the broken aſſociations. See No. II. 10. of this Section. It is thus likewiſe obſervable in ſome inflammations of the bowels, the too ſtrong efforts made by the muſcles to carry forwards the offending material fixes it more firmly in its place, and prevents the cure. So in endeavouring to recal to our memory ſome particular word of a ſentence, if we exert ourſelves too ſtrongly about it, we are leſs likely to regain it.

11. Catenated trains or tribes of action are eaſier diſſevered than catenated circles of action. Hence in epileptic fits the ſynchronous connected tribes of action, which keep the body erect, are diſſevered, but the circle of vital motions continues undiſturbed.

12. Sleep deſtroys the power of volition, and precludes the ſtimuli of external objects, and thence

thence diffevers the trains, of which thefe are a part; which confirms the other catenations, as thofe of the vital motions, fecretions, and abforptions; and produces the new trains of ideas, which conftitute our dreams.

II. 1. All the preceding circumftances of the catenations of animal motions will be more clearly underftood by the following example of a perfon learning mufic: and when we recollect the variety of mechanic arts, which are performed by affociated trains of mufcular actions catenated with the effects they produce, as in knitting, netting, weaving; and the greater variety of affociated trains of ideas caufed or catenated by volitions or fenfations, as in our hourly modes of reafoning, or imagining, or recollecting, we fhall gain fome idea of the innumerable catenated trains and circles of action, which form the tenor of our lives, and which began, and will only ceafe entirely with them.

2. When a young lady begins to learn mufic, fhe voluntarily applies herfelf to the characters of her mufic-book, and by many repetitions endeavours to catenate them with the proportions of found, of which they are fymbols. The ideas excited by the mufical characters are flowly connected with the keys of the harpfichord, and much effort is neceffary to produce every note with the proper finger, and in its due place and time; till at length a train of voluntary exertions

 becomes

becomes catenated with certain irritations. As the various notes by frequent repetitions become connected in the order, in which they are produced, a new catenation of ſenſitive exertions becomes mixed with the voluntary ones above deſcribed; and not only the muſical ſymbols of crotchets and quavers, but the auditory notes and tones at the ſame time, become ſo many ſucceſſive or ſynchronous links in this circle of catenated actions.

At length the motions of her fingers become catenated with the muſical characters; and theſe no ſooner ſtrike the eye, than the finger preſſes down the key without any voluntary attention between them; the activity of the hand being connected with the irritation of the figure or place of the muſical ſymbol on the retina; till at length by frequent repetitions of the ſame tune the movements of her fingers in playing, and the muſcles of the larynx in ſinging, become aſſociated with each other, and form part of thoſe intricate trains and circles of catenated motions, according with the ſecond article of the preceding propoſitions in No. 1. of this Section.

3. Beſides the facility, which by habit attends the execution of this muſical performance, a curious circumſtance occurs, which is, that when our young muſician has begun a tune, ſhe finds herſelf inclined to continue it; and that even when ſhe is careleſsly ſinging alone without attending

tending to her own ſong; according with the third preceding article.

4. At the ſame time that our young performer continues to play with great exactneſs this accuſtomed tune, ſhe can bend her mind, and that intenſely, on ſome other object, according with the fourth article of the preceding propoſitions.

The manuſcript copy of this work was lent to many of my friends at different times for the purpoſe of gaining their opinions and criticiſms on many parts of it, and I found the following anecdote written with a pencil oppoſite to this page, but am not certain by whom. "I remember ſeeing the pretty young actreſs, who ſucceeded Mrs. Arne in the performance of the celebrated Padlock, rehearſe the muſical parts at her harpſichord under the eye of her maſter with great taſte and accuracy; though I obſerved her countenance full of emotion, which I could not account for; at laſt ſhe ſuddenly burſt into tears; for ſhe had all this time been eyeing a beloved canary bird, ſuffering great agonies, which at that inſtant fell dead from its perch."

5. At the ſame time many other catenated circles of action are going on in the perſon of our fair muſician, as well as the motions of her fingers, ſuch as the vital motions, reſpiration, the movements of her eyes and eyelids, and of the intricate muſcles of vocality, according with the fifth preceding article.

6. If by any ſtrong impreſſion on the mind of our fair muſician ſhe ſhould be interrupted for a very inconſiderable time, ſhe can ſtill continue her performance, according to the ſixth article.

7. If however this interruption be greater, though the chain of actions be not diſſevered, it proceeds confuſedly, and our young performer continues indeed to play, but in a hurry without accuracy and elegance, till ſhe begins the tune again, according to the ſeventh of the preceding articles.

8. But if this interruption be ſtill greater, the circle of actions becomes entirely diſſevered, and ſhe finds herſelf immediately under the neceſſity to begin over again to recover the loſt catenation, according to the eighth preceding article.

9. Or in trying to recover it ſhe will ſing ſome diſſonant notes, or ſtrike ſome improper keys, according to the ninth preceding article.

10. A very remarkable thing attends this breach of catenation, if the performer has forgotten ſome word of her ſong, the more energy of mind ſhe uſes about it, the more diſtant is ſhe from regaining it; and artfully employs her mind in part on ſome other object, or endeavours to dull its perceptions, continuing to repeat, as it were inconſciouſly, the former part of the ſong, that ſhe remembers, in hopes to regain the loſt connexion.

For if the activity of the mind itſelf be more

energetic, or takes its attention more, than the connecting word, which is wanted; it will not perceive the flighter link of this loft word; as who liftens to a feeble found, muft be very filent and motionlefs; fo that in this cafe the very vigour of the mind itfelf feems to prevent it from regaining the loft catenation, as well as the too great exertion in endeavouring to regain it, according to the tenth preceding article.

We frequently experience, when we are doubtful about the fpelling of a word, that the greater voluntary exertion we ufe, that is the more intenfely we think about it, the further are we from regaining the loft affociation between the letters of it, but which readily recurs when we have become carelefs about it. In the fame manner, after having for an hour laboured to recollect the name of fome abfent perfon, it fhall feem, particularly after fleep, to come into the mind as it were fpontaneoufly; that is, the word we are in fearch of, was joined to the preceding one by affociation; this affociation being differered, we endeavour to recover it by volition; this very action of the mind ftrikes our attention more, than the faint link of affociation, and we find it impoffible by this means to retrieve the loft word. After fleep, when volition is entirely fufpended, the mind becomes capable of perceiving the fainter link of affociation, and the word is regained.

On this circumftance depends the impediment

of ſpeech before mentioned; the firſt ſyllable of a word is cauſable by volition, but the remainder of it is in common converſation introduced by its aſſociations with this firſt ſyllable acquired by long habit. Hence when the mind of the ſtammerer is vehemently employed on ſome idea of ambition of ſhining, or fear of not ſucceeding, the aſſociations of the motions of the muſcles of articulation with each other become diſſevered by this greater exertion, and he endeavours in vain by voluntary efforts to rejoin the broken aſſociation. For this purpoſe he continues to repeat the firſt ſyllable, which is cauſable by volition, and ſtrives in vain, by various diſtortions of countenance, to produce the next links, which are ſubject to aſſociation. See Claſs IV. 3. 1. 1.

11. After our accompliſhed muſician has acquired great variety of tunes and ſongs, ſo that ſome of them begin to ceaſe to be eaſily recollected, ſhe finds progreſſive trains of muſical notes more frequently forgotten, than thoſe which are compoſed of reiterated circles, according with the eleventh preceding article.

12. To finiſh our example with the preceding articles we muſt at length ſuppoſe, that our fair performer falls aſleep over her harpſichord; and thus by ſuſpenſion of volition, and the excluſion of external ſtimuli, ſhe diſſevers the trains and circles of her muſical exertions.

III. 1. Many

III. 1. Many of thefe circumftances of catenations of motions receive an eafy explanation from the four following confequences to the feventh law of animal caufation in Sect. IV. Thefe are, firft, that thofe fucceffions or combinations of animal motions, whether they were united by caufation, affociation, or catenation, which have been moft frequently repeated, acquire the ftrongeft connexion. Secondly, that of thefe, thofe, which have been lefs frequently mixed with other trains or tribes of motion, have the ftrongeft connexion. Thirdly, that of thefe, thofe, which were firft formed, have the ftrongeft connexion. Fourthly, that if an animal motion be excited by more than one caufation, affociation, or catenation, at the fame time, it will be performed with greater energy.

2. Hence alfo we underftand, why the catenations of irritative motions are more ftrongly connected than thofe of the other claffes, where the quantity of unmixed repetition has been equal; becaufe they were firft formed. Such are thofe of the fecerning and abforbent fyftems of veffels, where the action of the gland produces a fluid, which ftimulates the mouths of its correfpondent abforbents. The affociated motions feem to be the next moft ftrongly united, from their frequent repetition; and where both thefe circumftances unite, as in the vital motions, their

catenations are indiſſoluble but by the deſtruction of the animal.

3. Where a new link has been introduced into a circle of actions by ſome accidental defect of ſtimulus; if that defect of ſtimulus be repeated at the ſame part of the circle a ſecond or a third time, the defective motions thus produced, both by the repeated defect of ſtimulus and by their catenation with the parts of the circle of actions, will be performed with leſs and leſs energy. Thus if any perſon is expoſed to cold at a certain hour to-day, ſo long as to render ſome part of the ſyſtem for a time torpid; and is again expoſed to it at the ſame hour to-morrow, and the next day; he will be more and more affected by it, till at length a cold fit of fever is completely formed, as happens at the beginning of many of thoſe fevers, which are called nervous or low fevers. Where the patient has ſlight periodical ſhiverings and paleneſs for many days before the febrile paroxyſm is completely formed.

4. On the contrary, if the expoſure to cold be for ſo ſhort a time, as not to induce any conſiderable degree of torpor or quieſcence, and is repeated daily as above mentioned, it loſes its effect more and more at every repetition, till the conſtitution can bear it without inconvenience, or indeed without being conſcious of it. As in walking into the cold air in froſty weather. The ſame rule

rule is applicable to increafed ftimulus, as of heat, or vinous fpirit, within certain limits, as is applied in the two laft paragraphs to Deficient Stimulus, as is further explained in Sect. XXXVI. on the Periods of Difeafes.

5. Where irritation coincides with fenfation to produce the fame catenations of motion, as in inflammatory fevers, they are excited with ftill greater energy than by the irritation alone. So when children expect to be tickled in play, by a feather lightly paffed over the lips, or by gently vellicating the foles of their feet, laughter is moft vehemently excited; though they can ftimulate thefe parts with their own fingers unmoved. Here the pleafurable idea of playfulnefs coincides with the vellication; and there is no voluntary exertion ufed to diminifh the fenfation, as there would be, if a child fhould endeavour to tickle himfelf. See Sect. XXXIV. 1. 4.

6. And laftly, the motions excited by the junction of voluntary exertion with irritation are performed with more energy, than thofe by irritation fingly; as when we liften to fmall noifes, as to the ticking of a watch in the night, we perceive the moft weak founds, that are at other times unheeded. So when we attend to the irritative ideas of found in our ears, which are generally not attended to, we can hear them; and can fee the fpectra of objects, which remain in the eye, whenever we pleafe to exert our voluntary

tary power in aid of thoſe weak actions of the retina, or of the auditory nerve.

7. The temporary catenations of ideas, which are cauſed by the ſenſations of pleaſure or pain, are eaſily diſſevered either by irritations, as when a ſudden noiſe diſturbs a day-dream; or by the power of volition, as when we awake from ſleep. Hence in our waking hours, whenever an idea occurs, which is incongruous to our former experience, we inſtantly diſſever the train of imagination by the power of volition, and compare the incongruous idea with our previous knowledge of nature, and reject it. This operation of the mind has not yet acquired a ſpecific name, though it is exerted every minute of our waking hours; unleſs it may be termed INTUITIVE ANALOGY. It is an act of reaſoning of which we are unconſcious except from its effects in preſerving the congruity of our ideas, and bears the ſame relation to the ſenſorial power of volition, that irritative ideas, of which we are inconſcious except by their effects, do to the ſenſorial power of irritation; as the former is produced by volition without our attention to it, and the latter by irritation without our attention to them.

If on the other hand a train of imagination or of voluntary ideas are excited with great energy, and paſſing on with great vivacity, and become diſſevered by ſome violent ſtimulus, as the diſcharge of a piſtol near one's ear, another circum-

ſtance

ſtance takes place, which is termed SURPRISE; which by exciting violent irritation, and violent ſenſation, employs for a time the whole ſenſorial energy, and thus diſſevers the paſſing trains of ideas, before the power of volition has time to compare them with the uſual phenomena of nature. In this caſe fear is generally the companion of ſurpriſe, and adds to our embarraſſment, as every one experiences in ſome degree when he hears a noiſe in the dark, which he cannot inſtantly account for. This catenation of fear with ſurpriſe is owing to our perpetual experience of injuries from external bodies in motion, unleſs we are upon our guard againſt them. See Sect. XVIII. 17. XIX. 2.

Many other examples of the catenations of animal motions are explained in Sect. XXXVI. on the Periods of Diſeaſes.

SECT.

# SECT. XVIII.

## OF SLEEP.

*1. Volition is suspended in sleep. 2. Sensation continues. Dreams prevent delirium and inflammation. 3. Night-mare. 4. Ceaseless flow of ideas in dreams. 5. We seem to receive them by the senses. Optic nerve perfectly sensible in sleep. Eyes less dazzled after dreaming of visible objects. 6. Reverie, belief. 7. How we distinguish ideas from perceptions. 8. Variety of scenery in dreams, excellence of the sense of vision. 9. Novelty of combination in dreams. 10. Distinctness of imagery in dreams. 11. Rapidity of transaction in dreams. 12. Of measuring time. Of dramatic time and place. Why a dull play induces sleep, and an interesting one reverie. 13. Consciousness of our existence and identity in dreams. 14. How we awake sometimes suddenly, sometimes frequently. 15. Irritative motions continue in sleep, internal irritations are succeeded by sensation. Sensibility increases during sleep, and irritability. Morning dreams. Why epilepsies occur in sleep. Ecstasy of children. Case of convulsions in sleep. Cramp, why painful. Asthma. Morning sweats. Increase of heat. Increase of urine in sleep. Why more liable to take cold in sleep. Catarrh from thin night-caps. Why we feel chilly at the approach of sleep, and at waking in the open air. 16. Why the gout commences in sleep. Secretions are more copious in sleep, young animals and plants grow more in sleep. 17. Inconsistency of dreams. Absence of surprise in dreams. 18. Why we forget some dreams and not others. 19. Sleep-*

*19. Sleep talkers awake with surprise. 20. Remote causes of sleep. Atmosphere with less oxygene. Compression of the brain in the spina bifida. By whirling on a horizontal wheel. By cold. 21. Definition of sleep.*

1. THERE are four situations of our system, which in their moderate degrees are not usually termed diseases, and yet abound with many very curious and instructive phenomena; these are sleep, reverie, vertigo, drunkenness. These we shall previously consider, before we step forwards to develop the causes and cures of diseases with the modes of the operation of medicines.

As all those trains and tribes of animal motion, which are subjected to volition, were the last that were caused, their connexion is weaker than that of the other classes; and there is a peculiar circumstance attending this causation, which is, that it is entirely suspended during sleep; whilst the other classes of motion, which are more immediately necessary to life, as those caused by internal stimuli, for instance the pulsations of the heart and arteries, or those catenated with pleasurable sensation, as the powers of digestion, continue to strengthen their habits without interruption. Thus though man in his sleeping state is a much less perfect animal, than in his waking hours; and though he consumes more than one third of his life in this his irrational situation; yet is the wisdom of the Author of nature

ture manifeft even in this feeming imperfection of his work.

The truth of this affertion with refpect to the large mufcles of the body, which are concerned in locomotion, is evident; as no one in perfect fanity walks about in his fleep, or performs any domeftic offices: and in refpect to the mind, we never exercife our reafon or recollection in dreams; we may fometimes feem diftracted between contending paffions, but we never compare their objects, or deliberate about the acquifition of thofe objects, if our fleep is perfect. And though many fynchronous tribes or fucceffive trains of ideas may reprefent the houfes or walks, which have real exiftence, yet are they here introduced by their connexion with our fenfations, and are in truth ideas of imagination, not of recollection.

2. For our fenfations of pleafure and pain are experienced with great vivacity in our dreams; and hence all that motley group of ideas, which are caufed by them, called the ideas of imagination, with their various affociated trains, are in a very vivid manner acted over in the fenforium; and thefe fometimes call into action the larger mufcles, which have been much affociated with them; as appears from the muttering fentences, which fome people utter in their dreams, and from the obfcure barking of fleeping dogs, and the motions of their feet and noftrils.

This

This perpetual flow of the trains of ideas, which conftitute our dreams, and which are caufed by painful or pleafurable fenfation, might at firft view be conceived to be an ufelefs expenditure of fenforial power. But it has been fhewn, that thofe motions, which are perpetually excited, as thofe of the arterial fyftem by the ftimulus of the blood, are attended by a great accumulation of fenforial power, after they have been for a time fufpended; as the hot-fit of fever is the confequence of the cold one. Now as thefe trains of ideas caufed by fenfation are perpetually excited during our waking hours, if they were to be fufpended in fleep like the voluntary motions, (which are exerted only by intervals during our waking hours,) an accumulation of fenforial power would follow; and on our awaking a delirium would fupervene, fince thefe ideas caufed by fenfation would be produced with fuch energy, that we fhould miftake the trains of imagination for ideas excited by irritation; as perpetually happens to people debilitated by fevers on their firft awaking: for in thefe fevers with debility the general quantity of irritation being diminifhed, that of fenfation is increafed. In like manner if the actions of the ftomach, inteftines, and various glands, which are perhaps in part at leaft caufed by or catenated with agreeable fenfation, and which perpetually exift during our waking hours, were like the voluntary

motions ſuſpended in our ſleep; the great accumulation of ſenſorial power, which would neceſſarily follow, would be liable to excite inflammation in them.

3. When by our continued poſture in ſleep, ſome uneaſy ſenſations are produced, we either gradually awake by the exertion of volition, or the muſcles connected by habit with ſuch ſenſations alter the poſition of the body; but where the ſleep is uncommonly profound, and thoſe uneaſy ſenſations great, the diſeaſe called the incubus, or nightmare, is produced. Here the deſire of moving the body is painfully exerted, but the power of moving it, or volition, is incapable of action, till we awake. Many leſs diſagreeable ſtruggles in our dreams, as when we wiſh in vain to fly from terrifying objects, conſtitute a ſlighter degree of this diſeaſe. In awaking from the nightmare I have more than once obſerved, that there was no diſorder in my pulſe; nor do I believe the reſpiration is laborious, as ſome have affirmed. It occurs to people whoſe ſleep is too profound, and ſome diſagreeable ſenſation exiſts, which at other times would have awakened them, and have thence prevented the diſeaſe of nightmare; as after great fatigue or hunger with too large a ſupper and wine, which occaſion our ſleep to be uncommonly profound. See No. 14, of this Section.

4. As the larger muſcles of the body are much

more frequently excited by volition than by fenfation, they are but feldom brought into action in our fleep: but the ideas of the mind are by habit much more frequently connected with fenfation than with volition; and hence the ceafelefs flow of our ideas in dreams. Every one's experience will teach him this truth, for we all daily exert much voluntary mufcular motion: but few of mankind can bear the fatigue of much voluntary thinking.

5. A very curious circumftance attending thefe our fleeping imaginations is, that we feem to receive them by the fenfes. The mufcles, which are fubfervient to the external organs of fenfe, are connected with volition, and ceafe to act in fleep; hence the eyelids are clofed, and the tympanum of the ear relaxed; and it is probable a fimilarity of voluntary exertion may be neceffary for the perceptions of the other nerves of fenfe; for it is obferved that the papillæ of the tongue can be feen to become erected, when we attempt to tafte any thing extremely grateful. Hewfon Exper. Enquir. V. ii. 186. Albini Annot. Acad. L. i. c. 15. Add to this, that the immediate organs of fenfe have no objects to excite them in the darknefs and filence of the night; but their nerves of fenfe neverthelefs continue to poffefs their perfect activity fubfervient to all their numerous fenfitive connexions. This vivacity of our nerves of fenfe during the time of fleep is

evinced by a circumftance, which almoft every one muft at fome time or other have experienced; that is, if we fleep in the daylight, and endeavour to fee fome object in our dream, the light is exceedingly painful to our eyes; and after repeated ftruggles we lament in our fleep, that we cannot fee it. In this cafe I apprehend the eyelid is in fome degree opened by the vehemence of our fenfations; and, the iris being dilated, the optic nerve fhews as great or greater fenfibility than in our waking hours. See No. 15. of this Section.

When we are forcibly waked at midnight from profound fleep, our eyes are much dazzled with the light of the candle for a minute or two, after there has been fufficient time allowed for the contraction of the iris; which is owing to the accumulation of fenforial power in the organ of vifion during its ftate of lefs activity. But when we have dreamt much of vifible objects, this accumulation of fenforial power in the organ of vifion is leffened or prevented, and we awake in the morning without being dazzled with the light, after the iris has had time to contract itfelf. This is a matter of great curiofity, and may be thus tried by any one in the day-light. Clofe your eyes, and cover them with your hat; think for a minute on a tune, which you are accuftomed to, and endeavour to fing it with as little activity of mind as poffible. Suddenly uncover and open your eyes, and in one fecond of time

the iris will contract itſelf, but you will perceive the day more luminous for ſeveral ſeconds, owing to the accumulation of ſenſorial power in the optic nerve.

Then again cloſe and cover your eyes, and think intenſely on a cube of ivory two inches diameter, attending firſt to the north and ſouth ſides of it, and then to the other four ſides of it; then get a clear image in your mind's eye of all the ſides of the ſame cube coloured red; and then of it coloured green; and then of it coloured blue; laſtly, open your eyes as in the former experiment, and after the firſt ſecond of time allowed for the contraction of the iris, you will not perceive any increaſe of the light of the day, or dazzling; becauſe now there is no accumulation of ſenſorial power in the optic nerve; that having been expended by its action in thinking over viſible objects.

This experiment is not eaſy to be made at firſt, but by a few patient trials the fact appears very certain; and ſhews clearly, that our ideas of imagination are repetitions of the motions of the nerve, which were originally occaſioned by the ſtimulus of external bodies; becauſe they equally expend the ſenſorial power in the organ of ſenſe. See Sect. III. 4. which is analogous to our being as much fatigued by thinking as by labour.

6. Nor is it in our dreams alone, but even in our waking reveries, and in great efforts of in-

vention, so great is the vivacity of our ideas, that we do not for a time distinguish them from the real presence of substantial objects: though the external organs of sense are open, and surrounded with their usual stimuli. Thus whilst I am thinking over the beautiful valley, through which I yesterday travelled, I do not perceive the furniture of my room: and there are some, whose waking imaginations are so apt to run into perfect reverie, that in their common attention to a favourite idea they do not hear the voice of the companion, who accosts them, unless it is repeated with unusual energy.

This perpetual mistake in dreams and reveries, where our ideas of imagination are attended with a belief of the presence of external objects, evinces beyond a doubt, that all our ideas are repetitions of the motions of the nerves of sense, by which they were acquired; and that this belief is not, as some late philosophers contend, an instinct necessarily connected only with our perceptions.

7. A curious question demands our attention in this place; as we do not distinguish in our dreams and reveries between our perceptions of external objects, and our ideas of them in their absence, how do we distinguish them at any time? In a dream, if the sweetness of sugar occurs to my imagination, the whiteness and hardness of it, which were ideas usually connected with the sweetness, immediately follow in the train;

train; and I believe a material lump of ſugar preſent before my ſenſes: but in my waking hours, if the ſweetneſs occurs to my imagination, the ſtimulus of the table to my hand, or of the window to my eye, prevents the other ideas of the hardneſs and whiteneſs of the ſugar from ſucceeding; and hence I perceive the fallacy, and diſbelieve the exiſtence of objects correſpondent to thoſe ideas, whoſe tribes or trains are broken by the ſtimulus of other objects. And further in our waking hours, we frequently exert our volition in comparing preſent appearances with ſuch, as we have uſually obſerved; and thus correct the errors of one ſenſe by our general knowledge of nature by intuitive analogy. See Sect. XVII. 3. 7. Whereas in dreams the power of volition is ſuſpended, we can recollect and compare our preſent ideas with none of our acquired knowledge, and are hence incapable of obſerving any abſurdities in them.

By this criterion we diſtinguiſh our waking from our ſleeping hours, we can voluntarily recollect our ſleeping ideas, when we are awake, and compare them with our waking ones; but we cannot in our ſleep *voluntarily* recollect our waking ideas at all.

8. The vaſt variety of ſcenery, novelty of combination, and diſtinctneſs of imagery, are other curious circumſtances of our ſleeping imaginations. The variety of ſcenery ſeems to ariſe from the ſupe-

 rior

rior activity and excellence of our ſenſe of viſion; which in an inſtant unfolds to the mind extenſive fields of pleaſurable ideas; while the other ſenſes collect their objects ſlowly, and with little combination; add to this, that the ideas, which this organ preſents us with, are more frequently connected with our ſenſation than thoſe of any other.

9. The great novelty of combination is owing to another circumſtance; the trains of ideas, which are carried on in our waking thoughts, are in our dreams diſſevered in a thouſand places by the ſuſpenſion of volition, and the abſence of irritative ideas, and are hence perpetually falling into new catenations. As explained in Sect. XVI. 1. 9. For the power of volition is perpetually exerted during our waking hours in comparing our paſſing trains of ideas with our acquired knowledge of nature, and thus forms many intermediate links in their catenation. And the irritative ideas excited by the ſtimulus of the objects, with which we are ſurrounded, are every moment intruded upon us, and form other links of our unceaſing catenations of ideas.

10. The abſence of the ſtimuli of external bodies, and of volition, in our dreams renders the organs of ſenſe liable to be more ſtrongly affected by the powers of ſenſation, and of aſſociation. For our deſires or averſions, or the obtruſions of ſurrounding bodies, diſſever the ſenſitive and aſſociate tribes of ideas in our waking hours by

introducing

introducing thofe of irritation and volition amongft them. Hence proceeds the fuperior diftinctnefs of pleafurable or painful imagery in our fleep; for we recal the figure and the features of a long loft friend, whom we loved, in our dreams with much more accuracy and vivacity than in our waking thoughts. This circumftance contributes to prove, that our ideas of imagination are reiterations of thofe motions of our organs of fenfe, which were excited by external objects; becaufe while we are expofed to the ftimuli of prefent objects, our ideas of abfent objects cannot be fo diftinctly formed.

11. The rapidity of the fucceffion of tranfactions in our dreams is almoft inconceivable; infomuch that, when we are accidentally awakened by the jarring of a door, which is opened into our bedchamber, we fometimes dream a whole hiftory of thieves or fire in the very inftant of awaking.

During the fufpenfion of volition we cannot compare our other ideas with thofe of the parts of time in which they exift; that is, we cannot compare the imaginary fcene, which is before us, with thofe changes of it, which precede or follow it: becaufe this act of comparing requires recollection or voluntary exertion. Whereas in our waking hours, we are perpetually making this comparifon, and by that means our waking ideas are kept confiftent with each other by intuitive

 analogy;

analogy; but this comparifon retards the fucceffion of them, by occafioning their repetition. Add to this, that the tranfactions of our dreams confift chiefly of vifible ideas, and that a whole hiftory of thieves and fire may be *beheld* in an inftant of time like the figures in a picture.

12. From this incapacity of attending to the parts of time in our dreams, arifes our ignorance of the length of the night; which, but from our conftant experience to the contrary, we fhould conclude was but a few minutes, when our fleep is perfect. The fame happens in our reveries; thus when we are poffeffed with vehement joy, grief, or anger, time appears fhort, for we exert no volition to compare the prefent fcenery with the paft or future; but when we are compelled to perform thofe exercifes of mind or body, which are unmixed with paffion, as in travelling over a dreary country, time appears long; for our defire to finifh our journey occafions us more frequently to compare our prefent fituation with the parts of time or place, which are before and behind us.

So when we are enveloped in deep contemplation of any kind, or in reverie, as in reading a very interefting play or romance, we meafure time very inaccurately; and hence, if a play greatly affects our paffions, the abfurdities of paffing over many days or years, and of perpetual changes of place, are not perceived by the

audience; as is experienced by every one, who reads or fees fome plays of the immortal Shakfpeare; but it is neceffary for inferior authors to obferve thofe rules of the πιθανον and πρεπον inculcated by Ariftotle, becaufe their works do not intereft the paffions fufficiently to produce complete reverie.

Thofe works, however, whether a romance or a fermon, which do not intereft us fo much as to induce reverie, may neverthelefs incline us to fleep. For thofe pleafurable ideas, which are prefented to us, and are too gentle to excite laughter, (which is attended with interrupted voluntary exertions, as explained Sect. XXXIV. 1. 4.) and which are not accompanied with any other emotion, which ufually excites fome voluntary exertion, as anger, or fear, are liable to produce fleep; which confifts in a fufpenfion of all voluntary power. But if the ideas thus prefented to us, intereft our attention, and are accompanied with fo much pleafurable or painful fenfation as to excite our voluntary exertion at the fame time, reverie is the confequence. Hence an interefting play produces reverie, a tedious one produces fleep: in the latter we become exhaufted by attention, and are not excited to any voluntary exertion, and therefore fleep? in the former we are excited by fome emotion, which prevents by its pain the fufpenfion of volition, and

and in as much as it interests us, induces reverie, as explained in the next Section.

But when our ſleep is imperfect, as when we have determined to riſe in half an hour, time appears longer to us than in moſt other ſituations. Here our ſolicitude not to overſleep the determined time induces us in this imperfect ſleep to compare the quick changes of imagined ſcenery with the parts of time or place, they would have taken up, had they real exiſtence; and that more frequently than in our waking hours; and hence the time appears longer to us: and I make no doubt, but the permitted time appears long to a man going to the gallows, as the fear of its quick lapſe will make him think frequently about it.

13. As we gain our knowledge of time by comparing the preſent ſcenery with the paſt and future, and of place by comparing the ſituations of objects with each other; ſo we gain our idea of conſciouſneſs by comparing ourſelves with the ſcenery around us; and of identity by comparing our preſent conſciouſneſs with our paſt conſciouſneſs: as we never think of time or place, but when we make the compariſons above mentioned, ſo we never think of conſciouſneſs, but when we compare our own exiſtence with that of other objects; nor of identity, but when we compare our preſent and our paſt conſciouſneſs. Hence the conſciouſneſs of our own exiſtence, and of our identity,

identity, is owing to a voluntary exertion of our minds: and on that account in our complete dreams we neither meaſure time, are ſurpriſed at the ſudden changes of place, nor attend to our own exiſtence, or identity; becauſe our power of volition is ſuſpended. But all theſe circumſtances are more or leſs obſervable in our incomplete ones; for then we attend a little to the lapſe of time, and the changes of place, and to our own exiſtence; and even to our identity of perſon; for a lady ſeldom dreams, that ſhe is a ſoldier; nor a man, that he is brought to bed.

14. As long as our ſenſations only excite their ſenſual motions, or ideas, our ſleep continues ſound; but as ſoon as they excite deſires or averſions, our ſleep becomes imperfect; and when that deſire or averſion is ſo ſtrong, as to produce voluntary motions, we begin to awake; the larger muſcles of the body are brought into action to remove that irritation or ſenſation, which a continued poſture has cauſed; we ſtretch our limbs, and yawn, and our ſleep is thus broken by the accumulation of voluntary power.

Sometimes it happens, that the act of waking is ſuddenly produced, and this ſoon after the commencement of ſleep; which is occaſioned by ſome ſenſation ſo diſagreeable, as inſtantaneouſly to excite the power of volition; and a temporary action of all the voluntary motions ſuddenly ſucceeds, and we ſtart awake. This is ſometimes accompanied

accompanied with loud noife in the ears, and with fome degree of fear; and when it is in great excefs, fo as to produce continued convulfive motions of thofe mufcles, which are generally fubfervient to volition, it becomes epilepfy: the fits of which in fome patients generally commence during fleep. This differs from the night-mare defcribed in No. 3. of this Section, becaufe in that the difagreeable fenfation is not fo great as to excite the power of volition into action; for as foon as that happens, the difeafe ceafes.

Another circumftance, which fometimes awakes people foon after the commencement of their fleep, is where the voluntary power is already fo great in quantity as almoft to prevent them from falling afleep, and then a little accumulation of it foon again awakens them; this happens in cafes of infanity, or where the mind has been lately much agitated by fear or anger. There is another cicumftance in which fleep is likewife of fhort duration, which arifes from great debility, as after great over-fatigue, and in fome fevers, where the ftrength of the patient is greatly diminifhed: as in thefe cafes the pulfe intermits or flutters, and the refpiration is previoufly affected, it feems to originate from the want of fome voluntary efforts to facilitate refpiration, as when we are awake, and is further treated of in Vol. II. Clafs I. 2. 1. 2. on the Difeafes of the Voluntary Power. Art. Somnus interruptus.

15. We come now to thofe motions which depend on irritation. The motions of the arterial and glandular fyftems continue in our fleep, proceeding flower indeed, but ftronger and more uniformly, than in our waking hours, when they are incommoded by external ftimuli, or by the movements of volition; the motions of the mufcles fubfervient to refpiration continue to be ftimulated into action, and the other internal fenfes of hunger, thirft, and luft, are not only occafionally excited in our fleep, but their irritative motions are fucceeded by their ufual fenfations, and make a part of the farrago of our dreams. Thefe fenfations of the want of air, of hunger, thirft, and luft, in our dreams, contribute to prove, that the nerves of the external fenfes are alfo alive and excitable in our fleep; but as the ftimuli of external objects are either excluded from them by the darknefs and filence of the night, or their accefs to them is prevented by the fufpenfion of volition, thefe nerves of fenfe fall more readily into their connexions with fenfation and with affociation; becaufe much fenforial power, which during the day was expended in moving the external organs of fenfe in confequence of irritation from external ftimuli, or in confequence of volition, becomes now in fome degree accumulated, and renders the internal or immediate organs of fenfe more eafily excitable by the other fenforial powers. Thus in refpect to the eye, the irritation

irritation from external ſtimuli, and the power of volition during our waking hours, elevate the eye-lids, adapt the aperture of the iris to the quantity of light, the focus of the cryſtalline humour, and the angle of the optic axiſes to the diſtance of the object, all which perpetual activity during the day expends much ſenſorial power, which is ſaved during our ſleep.

Hence it appears, that not only thoſe parts of the ſyſtem, which are always excited by internal ſtimuli, as the ſtomach, inteſtinal canal, bile-ducts, and the various glands, but the organs of ſenſe alſo may be more violently excited into action by the irritation from internal ſtimuli, or by ſenſation, during our ſleep than in our waking hours; becauſe during the ſuſpenſion of volition, there is a greater quantity of the ſpirit of animation to be expended by the other ſenſorial powers. On this account our irritability to internal ſtimuli, and our ſenſibility to pain or pleaſure, is not only greater in ſleep, but increaſes as our ſleep is prolonged. Whence digeſtion and ſecretion are performed better in ſleep, than in our waking hours, and our dreams in the morning have greater variety and vivacity, as our ſenſibility increaſes, than at night when we firſt lie down. And hence epileptic fits, which are always occaſioned by ſome diſagreeable ſenſation, ſo frequently attack thoſe, who are ſubject to them, in their ſleep; becauſe at this time the ſyſtem

ſyſtem is more excitable by painful ſenſation in conſequence of internal ſtimuli; and the power of volition is then ſuddenly exerted to relieve this pain, as explained Sect. XXXIV. 1, 4.

There is a diſeaſe, which frequently affects children in the cradle, which is termed ecſtaſy, and ſeems to conſiſt in certain exertions to relieve painful ſenſation, in which the voluntary power is not ſo far excited as totally to awaken them, and yet is ſufficient to remove the diſagreeable ſenſation, which excites it; in this caſe changing the poſture of the child frequently relieves it.

I have at this time under my care an elegant young man about twenty-two years of age, who ſeldom ſleeps more than an hour without experiencing a convulſion fit; which ceaſes in about half a minute without any ſubſequent ſtupor. Large doſes of opium only prevented the paroxyſms, ſo long as they prevented him from ſleeping by the intoxication, which they induced. Other medicines had no effect on him. He was gently awakened every half hour for one night, but without good effect, as he ſoon ſlept again, and the fit returned at about the ſame periods of time, for the accumulated ſenſorial power, which occaſioned the increaſed ſenſibility to pain, was not thus exhauſted. This caſe evinces, that the ſenſibility of the ſyſtem to internal excitation increaſes, as our ſleep is prolonged; till the pain thus

thus occafioned produces voluntary exertion; which, when it is in its ufual degree, only awakens us; but when it is more violent, it occafions convulfions.

The cramp in the calf of the leg is another kind of convulfion, which generally commences in fleep, occafioned by the continual increafe of irritability from internal ftimuli, or of fenfibility, during that ftate of our exiftence. The cramp is a violent exertion to relieve pain, generally either of the fkin from cold, or of the bowels, as in fome diarrhœas, or from the mufcles having been previoufly overftretched, as in walking up or down fteep hills. But in thefe convulfions of the mufcles, which form the calf of the leg, the contraction is fo violent as to occafion another pain in confequence of their own too violent contraction, as foon as the original pain, which caufed the contraction, is removed. And hence the cramp, or fpafm, of thefe mufcles is continued without intermiffion by this new pain, unlike the alternate convulfions and remiffions in epileptic fits. The reafon, that the contraction of thefe mufcles of the calf of the leg is more violent during their convulfion than that of others, depends on the weaknefs of their antagonift mufcles; for after thefe have been contracted in their ufual action, as at every ftep in walking, they are again extended, not, as moft other mufcles are, by their antagonifts, but by the weight of the whole body

on

on the balls of the toes; and that weight applied to great mechanical advantage on the heel, that is, on the other end of the bone of the foot, which thus acts as a lever.

Another diseafe, the periods of which generally commence during our fleep, is the afthma. Whatever may be the remote caufe of paroxyfms of afthma, the immediate caufe of the convulfive refpiration, whether in the common afthma, or in what is termed the convulfive afthma, which are perhaps only different degrees of the fame difeafe, muft be owing to violent voluntary exertions to relieve pain, as in other convulfions; and the increafe of irritability to internal ftimuli, or of fenfibility, during fleep muft occafion them to commence at this time.

Debilitated people, who have been unfortunately accuftomed to great ingurgitation of fpirituous potation, frequently part with a great quantity of water during the night, but with not more than ufual in the day-time. This is owing to a beginning torpor of the abforbent fyftem, and precedes anafarca, which commences in the day, but is cured in the night by the increafe of the irritability of the abforbent fyftem during fleep, which thus imbibes from the cellular membrane the fluids, which had been accumulated there during the day; though it is poffible the horizontal pofition of the body may contribute fomething to this purpofe, and alfo the greater irri-

tability of ſome branches of the abſorbent veſſels, which open their mouths in the cells of the cellular membrane, than that of other branches.

As ſoon as a perſon begins to ſleep, the irritability and ſenſibility of the ſyſtem begin to increaſe, owing to the ſuſpenſion of volition and the excluſion of external ſtimuli. Hence the actions of the veſſels in obedience to internal ſtimulation become ſtronger and more energetic, though leſs frequent in reſpect to number. And as many of the ſecretions are increaſed, ſo the heat of the ſyſtem is gradually increaſed, and the extremities of feeble people, which had been cold during the day, become warm. Till towards morning many people become ſo warm, as to find it neceſſary to throw off ſome of their bed-clothes, as ſoon as they awake; and in others ſweats are ſo liable to occur towards morning during their ſleep.

Thus thoſe, who are not accuſtomed to ſleep in the open air, are very liable to take cold, if they happen to fall aſleep on a garden bench, or in a carriage with the window open. For as the ſyſtem is warmer during ſleep, as above explained, if a current of cold air affects any part of the body, a torpor of that part is more effectually produced, as when a cold blaſt of air through a key-hole or caſement falls upon a perſon in a warm room. In thoſe caſes the affected part poſſeſſes leſs irritability in reſpect to heat, from its having

having previously been exposed to a greater stimulus of heat, as in the warm room, or during sleep; and hence, when the stimulus of heat is diminished, a torpor is liable to ensue; that is, we take cold. Hence people who sleep in the open air, generally feel chilly both at the approach of sleep, and on their awaking; and hence many people are perpetually subject to catarrhs if they sleep in a less warm head-dress, than that which they wear in the day.

16. Not only the sensorial powers of irritation and of sensation, but that of association also appear to act with greater vigour during the suspension of volition in sleep. It will be shewn in another place, that the gout generally first attacks the liver, and that afterwards an inflammation of the ball of the great toe commences by association, and that of the liver ceases. Now as this change or metastasis of the activity of the system generally commences in sleep, it follows, that these associations of motion exist with greater energy at that time; that is, that the sensorial faculty of association, like those of irritation and of sensation, becomes in some measure accumulated during the suspension of volition.

Other associate tribes and trains of motions, as well as the irritative and sensitive ones, appear to be increased in their activity during the suspension of volition in sleep. As those which contri-

bute to circulate the blood, and to perform the various ſecretions; as well as the aſſociate tribes and trains of ideas, which contribute to furniſh the perpetual ſtreams of our dreaming imaginations.

In ſleep the ſecretions have generally been ſuppoſed to be diminiſhed, as the expectorated mucus in coughs, the fluids diſcharged in diarrhœas, and in ſalivation, except indeed the ſecretion of ſweat, which is often viſibly increaſed. This error ſeems to have ariſen from attention to the excretions rather than to the ſecretions. For the ſecretions, except that of ſweat, are generally received into reſervoirs, as the urine into the bladder, and the mucus of the inteſtines and lungs into their reſpective cavities; but theſe reſervoirs do not exclude theſe fluids immediately by their ſtimulus, but require at the ſame time ſome voluntary efforts, and therefore permit them to remain during ſleep. And as they thus continue longer in thoſe receptacles in our ſleeping hours, a greater part is abſorbed from them, and the remainder becomes thicker, and ſometimes in leſs quantity, though at the time it was ſecreted the fluid was in greater quantity than in our waking hours. Thus the urine is higher coloured after long ſleep; which ſhews, that a greater quantity has been ſecreted, and that more of the aqueous and ſaline part has been reabſorbed, and the earthy part left in the bladder; hence thick urine in fevers ſhews only

a greater

a greater action of the veſſels which ſecrete it in the kidneys, and of thoſe which abſorb it from the bladder.

The ſame happens to the mucus expectorated in coughs, which is thus thickened by abſorption of its aqueous and ſaline parts; and the ſame of the feces of the inteſtines. From hence it appears, and from what has been ſaid in No. 15 of this Section concerning the increaſe of irritability and of ſenſibility during ſleep, that the ſecretions are in general rather increaſed than diminiſhed during theſe hours of our exiſtence; and it is probable that nutrition is almoſt entirely performed in ſleep; and that young animals grow more at this time than in their waking hours, as young plants have long ſince been obſerved to grow more in the night, which is their time of ſleep.

17. Two other remarkable circumſtances of our dreaming ideas are their inconſiſtency, and the total abſence of ſurpriſe. Thus we ſeem to be preſent at more extraordinary metamorphoſes of animals or trees, than are to be met with in the fables of antiquity; and appear to be tranſported from place to place, which ſeas divide, as quickly as the changes of ſcenery are performed in a play-houſe; and yet are not ſenſible of their inconſiſtency, nor in the leaſt degree affected with ſurpriſe.

We muſt conſider this circumſtance more minutely.

nutely. In our waking trains of ideas, thofe that are inconfiftent with the ufual order of nature, fo rarely have occurred to us, that their connexion is the flighteft of all others: hence, when a confiftent train of ideas is exhaufted, we attend to the external ftimuli, that ufually furround us, rather than to any inconfiftent idea, which might otherwife prefent itfelf: and if an inconfiftent idea fhould intrude itfelf, we immediately compare it with the preceding one, and voluntarily reject the train it would introduce; this appears further in the Section on Reverie, in which ftate of the mind external ftimuli are not attended to, and yet the ftreams of ideas are kept confiftent by the efforts of volition. But as our faculty of volition is fufpended, and all external ftimuli are excluded in fleep, this flighter connexion of ideas takes place; and the train is faid to be inconfiftent; that is, diffimilar to the ufual order of nature.

But, when any confiftent train of fenfitive or voluntary ideas is flowing along, if any external ftimulus affects us fo violently, as to intrude irritative ideas forcibly into the mind, it difunites the former train of ideas, and we are affected with furprife. Thefe ftimuli of unufual energy or novelty not only difunite our common trains of ideas, but the trains of mufcular motions alfo, which have not been long eftablifhed by habit, and difturb thofe that have. Some people become motionlefs by great furprife, the fits of hiccup and of ague have been

been often removed by it, and it even affects the movements of the heart, and arteries; but in our fleep, all external ftimuli are excluded, and in confequence no furprife can exift. See Section XVII. 3. 7.

18. We frequently awake with pleafure from a dream, which has delighted us, without being able to recollect the tranfactions of it; unlefs perhaps at a diftance of time, fome analogous idea may introduce afrefh this forgotten train: and in our waking reveries we fometimes in a moment lofe the train of thought, but continue to feel the glow of pleafure, or the depreffion of fpirits, it occafioned: whilft at other times we can retrace with eafe thefe hiftories of our reveries and dreams.

The above explanation of furprife throws light upon this fubject. When we are fuddenly awak-ed by any violent ftimulus, the furprife totally difunites the trains of our fleeping ideas from thofe of our waking ones; but if we gradually awake, this does not happen; and we readily un-ravel the preceding trains of imagination.

19. There are various degrees of furprife; the more intent we are upon the train of ideas, which we are employed about, the more violent muft be the ftimulus that interrupts them, and the greater is the degree of furprife. I have ob-ferved dogs, who have flept by the fire, and by their obfcure barking and ftruggling have ap-

peared very intent on their prey, that ſhewed great ſurpriſe for a few ſeconds after their awaking by looking eagerly around them; which they did not do at other times of waking. And an intelligent friend of mine has remarked, that his lady, who frequently ſpeaks much and articulately in her ſleep, could never recollect her dreams in the morning, when this happened to her: but that when ſhe did not ſpeak in her ſleep, ſhe could always recollect them.

Hence, when our ſenſations act ſo ſtrongly in ſleep as to influence the larger muſcles, as in thoſe, who talk or ſtruggle in their dreams; or in thoſe, who are affected with complete reverie (as deſcribed in the next Section), great ſurpriſe is produced, when they awake; and theſe as well as thoſe, who are completely drunk or delirious, totally forget afterwards their imaginations at thoſe times.

20. As the immediate cauſe of ſleep conſiſts in the ſuſpenſion of volition, it follows, that whatever diminiſhes the general quantity of ſenſorial power, or derives it from the faculty of volition, will conſtitute a remote cauſe of ſleep; ſuch as fatigue from muſcular or mental exertion, which diminiſhes the general quantity of ſenſorial power; or an increaſe of the ſenſitive motions, as by attending to ſoft muſic, which diverts the ſenſorial power from the faculty of volition; or laſtly, by increaſe of the irritative

motions,

motions, as by wine, or food, or warmth; which not only by their expenditure of ſenſorial power diminiſh the quantity of volition; but alſo by their producing pleaſureable ſenſations (which occaſion other muſcular or ſenſual motions in conſequence), doubly decreaſe the voluntary power, and thus more forcibly produce ſleep. See Sect. XXXIV. 1. 4.

Another method of inducing ſleep is delivered in a very ingenious work lately publiſhed by Dr. Beddoes. Who after lamenting that opium frequently occaſions reſtleſſneſs, thinks, "that in moſt caſes it would be better to induce ſleep by the abſtraction of ſtimuli, than by exhauſting the excitability;" and adds, "upon this principle we could not have a better ſoporific than an atmoſphere with a diminiſhed proportion of oxygene air, and that common air might be admitted after the patient was aſleep." (Obſerv. on Calculus, &c. by Dr. Beddoes, Murray.) If it ſhould be found to be true, that the excitability of the ſyſtem depends on the quantity of oxygene abſorbed by the lungs in reſpiration according to the theory of Dr. Beddoes, and of M. Girtanner, this idea of ſleeping in an atmoſphere with leſs oxygene in its compoſition might be of great ſervice in epileptic caſes, and in cramp, and even in fits of the aſthma, where their periods commence from the increaſe of irritability during ſleep.

Sleep is likewiſe ſaid to be induced by mechanic

nic preſſure on the brain in the caſes of ſpina bifida. Where there has been a defect of one of the vertebræ of the back, a tumour is protruded in conſequence; and, whenever this tumour has been compreſſed by the hand, ſleep is ſaid to be induced, becauſe the whole of the brain both within the head and ſpine becomes compreſſed by the retroceſſion of the fluid within the tumour. But by what means a compreſſion of the brain induces ſleep has not been explained, but probably by diminiſhing the ſecretion of ſenſorial power, and then the voluntary motions become ſuſpended previouſly to the irritative ones, as occurs in moſt dying perſons.

Another way of procuring ſleep mechanically was related to me by Mr. Brindley, the famous canal engineer, who was brought up to the buſineſs of a mill-wright; he told me, that he had more than once ſeen the experiment of a man extending himſelf acroſs the large ſtone of a corn-mill, and that by gradually letting the ſtone whirl, the man fell aſleep, before the ſtone had gained its full velocity, and he ſuppoſed would have died without pain by the continuance or increaſe of the motion. In this caſe the centrifugal motion of the head and feet muſt accumulate the blood in both thoſe extremities of the body, and thus compreſs the brain.

Laſtly, we ſhould mention the application of cold; which, when in a leſs degree, produces watchfulneſs

watchfulneſs by the pain it occaſions, and the tremulous convulſions of the ſubcutaneous muſcles; but when it is applied in great degree, is ſaid to produce ſleep. To explain this effect it has been ſaid, that as the veſſels of the ſkin and extremities become firſt torpid by the want of the ſtimulus of heat, and as thence leſs blood is circulated through them, as appears from their paleneſs, a greater quantity of blood poured upon the brain produces ſleep by its compreſſion of that organ. But I ſhould rather imagine, that the ſenſorial power becomes exhauſted by the convulſive actions in conſequence of the pain of cold, and of the voluntary exerciſe previouſly uſed to prevent it, and that the ſleep is only the beginning to die, as the ſuſpenſion of voluntary power in lingering deaths precedes for many hours the extinction of the irritative motions.

21. The following are the characteriſtic circumſtances attending perfect ſleep.

1. The power of volition is totally ſuſpended.

2. The trains of ideas cauſed by ſenſation proceed with greater facility and vivacity; but become inconſiſtent with the uſual order of nature. The muſcular motions cauſed by ſenſation continue; as thoſe concerned in our evacuations during infancy, and afterwards in digeſtion, and in priapiſmus.

3. The irritative muſcular motions continue, as thoſe concerned in the circulation, in ſecretion,

tion, in reſpiration. But the irritative ſenſual motions, or ideas, are not excited; as the immediate organs of ſenſe are not ſtimulated into action by external objects, which are excluded by the external organs of ſenſe; which are not in ſleep adapted to their reception by the power of volition, as in our waking hours.

4. The aſſociate motions continue; but their firſt link is not excited into action by volition, or by external ſtimuli. In all reſpects, except thoſe above mentioned, the three laſt ſenſorial powers are ſomewhat increaſed in energy during the ſuſpenſion of volition, owing to the conſequent accumulation of the ſpirit of animation.

SECT.

# SECT. XIX.

## OF REVERIE.

*1. Various degrees of reverie. 2. Sleep-walkers. Caſe of a young lady. Great ſurpriſe at awaking. And total forgetfulneſs of what paſſed in reverie. 3. No ſuſpenſion of volition in reverie. 4. Senſitive motions continue, and are conſiſtent. 5. Irritative motions continue, but are not ſucceeded by ſenſation. 6. Volition neceſſary for the perception of feeble impreſſions. 7. Aſſociated motions continue. 8. Nerves of ſenſe are irritable in ſleep, but not in reverie. 9. Somnambuli are not aſleep. Contagion received but once. 10. Definition of reverie.*

1. When we are employed with great ſenſation of pleaſure, or with great efforts of volition, in the purſuit of ſome intereſting train of ideas, we ceaſe to be conſcious of our exiſtence, are in attentive to time and place, and do not diſtinguiſh this train of ſenſitive and voluntary ideas from the irritative ones excited by the preſence of external objects, though our organs of ſenſe are ſurrounded with their accuſtomed ſtimuli, till at length this intereſting train of ideas becomes exhauſted, or the appulſes of external objects are applied with unuſual violence, and we return with ſurpriſe,

ſurpriſe, or with regret, into the common track of life. This is termed reverie or ſtudium.

In ſome conſtitutions theſe reveries continue a conſiderable time, and are not to be removed without greater difficulty, but are experienced in a leſs degree by us all; when we attend earneſtly to the ideas excited by volition or ſenſation, with their aſſociated connexions, but are at the ſame time conſcious at intervals of the ſtimuli of ſurrounding bodies. Thus in being preſent at a play, or in reading a romance, ſome perſons are ſo totally abſorbed as to forget their uſual time of ſleep, and to neglect their meals; while others are ſaid to have been ſo involved in voluntary ſtudy as not to have heard the diſcharge of artillery; and there is a ſtory of an Italian politician, who could think ſo intenſely on other ſubjects, as to be inſenſible to the torture of the rack.

From hence it appears, that theſe catenations of ideas and muſcular motions, which form the trains of reverie, are compoſed both of voluntary and ſenſitive aſſociations of them; and that theſe ideas differ from thoſe of delirium or of ſleep, as they are kept conſiſtent by the power of volition; and they differ alſo from the trains of ideas belonging to inſanity, as they are as frequently excited by ſenſation as by volition. But laſtly, that the whole ſenſorial power is ſo employed on theſe trains of complete reverie, that like the violent ef-

forts of volition, as in convulſions or inſanity; or like the great activity of the irritative motions in drunkenneſs; or of the ſenſitive motions in delirium; they preclude all ſenſation conſequent to external ſtimulus.

2. Thoſe perſons, who are ſaid to walk in their ſleep, are affected with reverie to ſo great a degree, that it becomes a formidable diſeaſe; the eſſence of which conſiſts in the inaptitude of the mind to attend to external ſtimuli. Many hiſtories of this diſeaſe have been publiſhed by medical writers; of which there is a very curious one in the Lauſanne Tranſactions. I ſhall here ſubjoin an account of ſuch a caſe, with its cure, for the better illuſtration of this ſubject.

A very ingenious and elegant young lady, with light eyes and hair, about the age of ſeventeen, in other reſpects well, was ſuddenly ſeized ſoon after her uſual menſtruation with this very wonderful malady. The diſeaſe began with vehement convulſions of almoſt every muſcle of her body, with great but vain efforts to vomit, and the moſt violent hiccoughs, that can be conceived: theſe were ſucceeded in about an hour with a fixed ſpaſm; in which one hand was applied to her head, and the other to ſupport it: in about half an hour theſe ceaſed, and the reverie began ſuddenly, and was at firſt manifeſt by the look of her eyes and countenance, which ſeemed to expreſs attention. Then ſhe converſed aloud with imaginary

perſons

perſons with her eyes open, and could not for about an hour be brought to attend to the ſtimulus of external objects by any kind of violence, which it was proper to uſe: theſe ſymptoms returned in this order every day for five or ſix weeks.

Theſe converſations were quite conſiſtent, and we could underſtand, what ſhe ſuppoſed her imaginary companions to anſwer, by the continuation of her part of the diſcourſe. Sometimes ſhe was angry, at other times ſhewed much wit and vivacity, but was moſt frequently inclined to melancholy. In theſe reveries ſhe ſometimes ſung over ſome muſic with accuracy, and repeated whole pages from the Engliſh poets. In repeating ſome lines from Mr. Pope's works ſhe had forgot one word, and began again, endeavouring to recollect it; when ſhe came to the forgotten word, it was ſhouted aloud in her ear, and this repeatedly, to no purpoſe; but by many trials ſhe at length regained it herſelf.

Theſe paroxyſms were terminated with the appearance of inexpreſſible ſurpriſe, and great fear, from which ſhe was ſome minutes in recovering herſelf, calling on her ſiſter with great agitation, and very frequently underwent a repetition of convulſions, apparently from the pain of fear. See Sect. XVII. 3. 7.

After having thus returned for about an hour every day for two or three weeks, the reveries ſeemed to become leſs complete, and ſome of their

their circumſtances varied; ſo that ſhe could walk about the room in them without running againſt any of the furniture; though theſe motions were at firſt very unſteady and tottering. And afterwards ſhe once drank a diſh of tea, when the whole apparatus of the tea-table was ſet before her; and expreſſed ſome ſuſpicion, that a medicine was put into it, and once ſeemed to ſmell of a tuberoſe, which was in flower in her chamber, and deliberated aloud about breaking it from the ſtem, ſaying, "it would make her ſiſter ſo charmingly angry." At another time in her melancholy moments ſhe heard the ſound of a paſſing bell, "I wiſh I was dead," ſhe cried, liſtening to the bell, and then taking off one of her ſhoes, as ſhe ſat upon the bed, "I love the colour black," ſays ſhe, "a little wider, and a little longer, even this might make me a coffin!"—Yet it is evident, ſhe was not ſenſible at this time, any more than formerly, of ſeeing or hearing any perſon about her; indeed when great light was thrown upon her by opening the ſhutters of the window, her trains of ideas ſeemed leſs melancholy; and when I have forcibly held her hands, or covered her eyes, ſhe appeared to grow impatient, and would ſay, ſhe could not tell what to do, for ſhe could neither ſee nor move. In all theſe circumſtances her pulſe continued unaffected as in health. And when the paroxyſm was

 over,

over, ſhe could never recollect a ſingle idea of what had paſſed in it.

This aſtoniſhing diſeaſe, after the uſe of many other medicines and applications in vain, was cured by very large doſes of opium given about an hour before the expected returns of the paroxyſms; and after a few relapſes, at the intervals of three or four months, entirely diſappeared. But ſhe continued at times to have other ſymptoms of epilepſy.

3. We ſhall only here conſider, what happened during the time of her reveries, as that is our preſent ſubject; the fits of convulſion belong to another part of this treatiſe. Sect. XXXIV. 44.

There ſeems to have been no ſuſpenſion of volition during the fits of reverie, becauſe ſhe endeavoured to regain the loſt idea in repeating the lines of poetry, and deliberated about breaking the tuberoſe, and ſuſpected the tea to have been medicated.

4. The ideas and muſcular movements depending on ſenſation were exerted with their uſual vivacity, and were kept from being inconſiſtent by the power of volition, as appeared from her whole converſation, and was explained in Sect. XVII. 3. 7. and XVIII. 16.

5. The ideas and motions dependant on irritation during the firſt weeks of her diſeaſe, whilſt the reverie was complete, were never ſucceeded

by

by the ſenſation of pleaſure or pain; as ſhe neither ſaw, heard, nor felt any of the ſurrounding objects. Nor was it certain that any irritative motions ſucceeded the ſtimulus of external objects, till the reverie became leſs complete, and then ſhe could walk about the room without running againſt the furniture of it. Afterwards, when the reverie became ſtill leſs complete from the uſe of opium, ſome few irritations were at times ſucceeded by her attention to them. As when ſhe ſmelt at a tuberoſe, and drank a diſh of tea, but this only when ſhe ſeemed voluntarily to attend to them.

6. In common life when we liſten to diſtant ſounds, or wiſh to diſtinguiſh objects in the night, we are obliged ſtrongly to exert our volition to diſpoſe the organs of ſenſe to perceive them, and to ſuppreſs the other trains of ideas, which might interrupt theſe feeble ſenſations. Hence in the preſent hiſtory the ſtrongeſt ſtimuli were not perceived, except when the faculty of volition was exerted on the organ of ſenſe; and then even common ſtimuli were ſometimes perceived: for her mind was ſo ſtrenuouſly employed in purſuing its own trains of voluntary or ſenſitive ideas, that no common ſtimuli could ſo far excite her attention as to diſunite them; that is, the quantity of volition or of ſenſation already exiſting was greater than any, which could be produced in conſequence of common degrees of

 ſtimulation.

ſtimulation. But the few ſtimuli of the tuberoſe, and of the tea, which ſhe did perceive, were ſuch, as accidentally coincided with the trains of thought, which were paſſing in her mind; and hence did not diſunite thoſe trains, and create ſurpriſe. And their being perceived at all was owing to the power of volition preceding or coinciding with that of irritation.

This explication is countenanced by a fact mentioned concerning a ſomnambuliſt in the Lauſanne Tranſactions, who ſometimes opened his eyes for a ſhort time to examine, where he was, or where his ink-pot ſtood, and then ſhut them again, dipping his pen into the pot every now and then, and writing on, but never opening his eyes afterwards, although he wrote on from line to line regularly, and corrected ſome errors of the pen, or in ſpelling: ſo much eaſier was it to him to refer to his ideas of the poſitions of things, than to his perceptions of them.

7. The aſſociated motions perſiſted in their uſual channel, as appeared by the combinations of her ideas, and the uſe of her muſcles, and the equality of her pulſe; for the natural motions of the arterial ſyſtem, though originally excited like other motions by ſtimulus, ſeem in part to continue by their aſſociation with each other. As the heart of a viper pulſates long after it is cut out of the body, and removed from the ſtimulus of the blood.

8. In

8. In the ſection on ſleep, it was obſerved that the nerves of ſenſe are equally alive and ſuſceptible to irritation in that ſtate, as when we are awake; but that they are ſecluded from ſtimulating objects, or rendered unfit to receive them: but in complete reverie the reverſe happens, the immediate organs of ſenſe are expoſed to their uſual ſtimuli; but are either not excited into action at all, or not into ſo great action, as to produce attention or ſenſation.

The total forgetfulneſs of what paſſes in reveries; and the ſurpriſe on recovering from them, are explained in Section XVIII. 19. and in Section XVII. 3. 7.

9. It appears from hence, that reverie is a diſeaſe of the epileptic or cataleptic kind, ſince the paroxyſms of this young lady always began and frequently terminated with convulſions; and though in its greateſt degree it has been called ſomnambulation, or ſleep-walking, it is totally different from ſleep; becauſe the eſſential character of ſleep conſiſts in a total ſuſpenſion of volition, which in reverie is not affected; the eſſential character of reverie conſiſts not in the abſence of thoſe irritative motions of our ſenſes, which are occaſioned by the ſtimulus of external objects, but in their never being productive of ſenſation. So that during a fit of reverie that ſtrange event happens to the whole ſyſtem of nerves, which occurs only to ſome particular branches of them in

thofe, who are a fecond time expofed to the action of contagious matter. If the matter of the fmall-pox be inferted into the arm of one, who has previoufly had that difeafe, it will ftimulate the wound, but the general fenfation or inflammation of the fyftem does not follow, which conftitutes the difeafe. See Sect. XII. 7. 6. XXXIII. 2. 8.

10. The following is the definition or character of complete reverie. 1. The irritative motions occafioned by internal ftimuli continue, thofe from the ftimuli of external objects are either not produced at all, or are never fucceeded by fenfation or attention, unlefs they are at the fame time excited by volition. 2. The fenfitive motions continue, and are kept confiftent by the power of volition. 3. The voluntary motions continue undifturbed. 4. The affociate motions continue undifturbed.

Two other cafes of reverie are related in Section XXXIV. 3. which further evince, that reverie is an effort of the mind to relieve fome painful fenfation, and is hence allied to convulfion, and to infanity. Another cafe is related in Clafs III. 1. 2. 2.

SECT.

# SECT. XX.

## OF VERTIGO.

*1. We determine our perpendicularity by the apparent motions of objects. A person hood-winked cannot walk in a ſtraight line. Dizzineſs on looking from a tower, in a room ſtained with uniform lozenges, on riding over ſnow. 2. Dizzineſs from moving objects. A whirling wheel. Fluctuations of a river. Experiment with a child. 3. Dizzineſs from our own motions and thoſe of other objects. Riding over a broad ſtream. Sea-ſickneſs. 5. Of turning round on one foot. Derviſes in Turkey. Attention of the mind prevents ſlight ſea-ſickneſs. After a voyage ideas of vibratory motions are ſtill perceived on ſhore. 6. Ideas continue ſome time after they are excited. Circumſtances of turning on one foot, ſtanding on a tower, and walking in the dark, explained. 7. Irritative ideas of apparent motions. Irritative ideas of ſounds. Battemens of the ſound of bells and organ-pipes. Vertiginous noiſe in the head. Irritative motions of the ſtomach, inteſtines, and glands. 8. Symptoms that accompany vertigo. Why vomiting comes on in ſtrokes of the palſy. By the motion of a ſhip. By injuries on the head. Why motion makes ſick people vomit. 9. Why drunken people are vertiginous. Why a ſtone in the ureter, or bile-duct, produces vomiting. 10. Why after a voyage ideas of vibratory motions are perceived on ſhore. 11. Kinds of vertigo and their cure. 12. Definition of vertigo.*

1. In learning to walk we judge of the diſtances of the objects, which we approach, by the eye;

and by obſerving their perpendicularity determine our own. This circumſtance not having been attended to by the writers on viſion, the diſeaſe called vertigo or dizzineſs has been little underſtood.

When any perſon loſes the power of muſcular action, whether he is erect or in a ſitting poſture, he ſinks down upon the ground; as is ſeen in fainting fits, and other inſtances of great debility. Hence it follows, that ſome exertion of muſcular power is neceſſary to preſerve our perpendicular attitude. This is performed by proportionally exerting the antagoniſt muſcles of the trunk, neck, and limbs; and if at any time in our locomotions we find ourſelves inclining to one ſide, we either reſtore our equilibrium by the efforts of the muſcles on the other ſide, or by moving one of our feet extend the baſe, which we reſt upon, to the new centre of gravity.

But the moſt eaſy and habitual manner of determining our want of perpendicularity, is by attending to the apparent motion of the objects within the ſphere of diſtinct viſion; for this apparent motion of objects, when we incline from our perpendicularity, or begin to fall, is as much greater than the real motion of the eye, as the diameter of the ſphere of diſtinct viſion is to our perpendicular height.

Hence no one, who is hood-winked, can walk

in a ſtraight line for a hundred ſteps together; for he inclines ſo greatly, before he is warned of his want of perpendicularity by the ſenſe of touch, not having the apparent motions of ambient objects to meaſure this inclination by, that he is neceſſitated to move one of his feet outwards, to the right or to the left, to ſupport the new centre of gravity, and thus errs from the line he endeavours to proceed in.

For the ſame reaſon many people become dizzy, when they look from the ſummit of a tower, which is raiſed much above all other objects, as theſe objects are out of the ſphere of diſtinct viſion, and they are obliged to balance their bodies by the leſs accurate feelings of their muſcles.

There is another curious phenomenon belonging to this place, if the circumjacent viſible objects are ſo ſmall, that we do not diſtinguiſh their minute parts; or ſo ſimilar, that we do not know them from each other; we cannot determine our perpendicularity by them. Thus in a room hung with a paper, which is coloured over with ſimilar ſmall black lozenges or rhomboids, many people become dizzy; for when they begin to fall, the next and the next lozenge ſucceeds upon the eye; which they miſtake for the firſt, and are not aware, that they have any apparent motion. But if you fix a ſheet of paper, or draw any other figure, in the midſt of theſe lozenges, the charm ceaſes,

ceafes, and no dizzinefs is perceptible.—The fame occurs, when we ride over a plain covered with fnow without trees or other eminent objects.

2. But after having compared vifible objects at reft with the fenfe of touch, and learnt to diftinguifh their fhapes and fhades, and to meafure our want of perpendicularity by their apparent motions, we come to confider them in real motion. Here a new difficulty occurs, and we require fome experience to learn the peculiar mode of motion of any moving objects, before we can make ufe of them for the purpofes of determining our perpendicularity. Thus fome people become dizzy at the fight of a whirling wheel, or by gazing on the fluctuations of a river, if no fteady objects are at the fame time within the fphere of their diftinct vifion; and when a child firft can ftand erect upon his legs, if you gain his attention to a white handkerchief fteadily extended like a fail, and afterwards make it undulate, he inftantly lofes his perpendicularity, and tumbles on the ground.

3. A fecond difficulty we have to encounter is to diftinguifh our own real movements from the apparent motions of objects. Our daily practice of walking and riding on horfeback foon inftructs us with accuracy to difcern thefe modes of motion, and to afcribe the apparent motions of the ambient objects to ourfelves; but thofe, which we have not acquired by repeated habit, continue

to confound us. So as we ride on horfeback the trees and cottages, which occur to us, appear at reft; we can meafure their diftances with our eye, and regulate our attitude by them; yet if we carelefsly attend to diftant hills or woods through a thin hedge, which is near us, we obferve the jumping and progreffive motions of them; as this is increafed by the parallax of thefe objects; which we have not habituated ourfelves to attend to. When firft an European mounts an elephant fixteen feet high, and whofe mode of motion he is not accuftomed to, the objects feem to undulate, as he paffes, and he frequently becomes fick and vertiginous, as I am well informed. Any other unufual movement of our bodies has the fame effect, as riding backwards in a coach, fwinging on a rope, turning round fwiftly on one leg, fcating on the ice, and a thoufand others. So after a patient has been long confined to his bed, when he firft attempts to walk, he finds himfelf vertiginous, and is obliged by practice to learn again the particular modes of the apparent motions of objects, as he walks by them.

4. A third difficulty, which occurs to us in learning to balance ourfelves by the eye, is, when both ourfelves and the circumjacent objects are in real motion. Here it is neceffary, that we fhould be habituated to both thefe modes of motion in order to preferve our prependicularity. Thus on horfeback we accurately

accurately obferve another perfon, whom we meet, trotting towards us, without confounding his jumping and progreffive motion with our own, becaufe we have been accuftomed to them both; that is, to undergo the one, and to fee the other at the fame time. But in riding over a broad and fluctuating ftream, though we are well experienced in the motions of our horfe, we are liable to become dizzy from our inexperience in that of the water. And when firft we go on fhip-board, where the movements of ourfelves, and the movements of the large waves are both new to us, the vertigo is almoft unavoidable with the terrible ficknefs, which attends it. And this I have been affured has happened to feveral from being removed from a large fhip into a fmall one; and again from a fmall one into a man of war.

5. From the foregoing examples it is evident, that, when we are furrounded with unufual motions, we lofe our perpendicularity: but there are fome peculiar circumftances attending this effect of moving objects, which we come now to mention, and fhall hope from the recital of them to gain fome infight into the manner of their production.

When a child moves round quick upon one foot, the circumjacent objects become quite indiftinct, as their diftance increafes their apparent motions; and this great velocity confounds both their forms, and their colours, as is feen in whirl-

ing

ing round a many coloured wheel; he then loſes his uſual method of balancing himſelf by viſion, and begins to ſtagger, and attempts to recover himſelf by his muſcular feelings. This ſtaggering adds to the inſtability of the viſible objects by giving a vibratory motion beſides their rotatory one. The child then drops upon the ground, and the neighbouring objects ſeem to continue for ſome ſeconds of time to circulate around him, and the earth under him appears to librate like a balance. In ſome ſeconds of time theſe ſenſations of a continuation of the motion of objects vaniſh; but if he continues turning round ſomewhat longer, before he falls, ſickneſs and vomiting are very liable to ſucceed. But none of theſe circumſtances affect thoſe who have habituated themſelves to this kind of motion, as the derviſes in Turkey, amongſt whom theſe ſwift gyrations are a ceremony of religion.

In an open boat paſſing from Leith to Kinghorn in Scotland, a ſudden change of the wind ſhook the undiſtended ſail, and ſtopt our boat; from this unuſual movement the paſſengers all vomited except myſelf. I obſerved, that the undulation of the ſhip, and the inſtability of all viſible objects, inclined me ſtrongly to be ſick; and this continued or increaſed, when I cloſed my eyes, but as often as I bent my attention with energy on the management and mechaniſm of the ropes and ſails, the ſickneſs ceaſed; and re-

curred

curred again, as often as I relaxed this attention; and I am aſſured by a gentleman of obſervation and veracity, that he has more than once obſerved, when the veſſel has been in immediate danger, that the ſea-ſickneſs of the paſſengers has inſtantaneouſly ceaſed, and recurred again, when the danger was over.

Thoſe, who have been upon the water in a boat or ſhip ſo long, that they have acquired the neceſſary habits of motion upon that unſtable element, at their return on land frequently think in their reveries, or between ſleeping and waking, that they obſerve the room, they ſit in, or ſome of its furniture, to librate like the motion of the veſſel. This I have experienced myſelf, and have been told, that after long voyages, it is ſome time before theſe ideas entirely vaniſh. The ſame is obſervable in a leſs degree after having travelled ſome days in a ſtage coach, and particularly when we lie down in bed, and compoſe ourſelves to ſleep; in this caſe it is obſervable, that the rattling noiſe of the coach, as well as the undulatory motion, haunts us. The drunken vertigo, and the vulgar cuſtom of rocking children, will be conſidered in the next Section.

6. The motions, which are produced by the power of volition, may be immediately ſtopped by the exertion of the ſame power on the antagoniſt muſcles; otherwiſe theſe with all the other claſſes of motion continue to go on, ſome time

after

after they are excited, as the palpitation of the heart continues after the object of fear, which occafioned it, is removed. But this circumftance is in no clafs of motions more remarkable than in thofe dependent on irritation; thus if any one looks at the fun, and then covers his eyes with his hand, he will for many feconds of time perceive the image of the fun marked on his retina: a fimilar image of all other vifible objects would remain fome time formed on the retina, but is extinguifhed by the perpetual change of the motions of this nerve in our attention to other objects. To this muft be added, that the longer time any movements have continued to be excited without fatigue to the organ, the longer will they continue fpontaneoufly, after the excitement is withdrawn: as the tafte of tobacco in the mouth after a perfon has been fmoking it. This tafte remains fo ftrong, that if a perfon continues to draw air through a tobacco pipe in the dark, after having been fmoking fome time, he cannot diftinguifh whether his pipe be lighted or not.

From thefe two confiderations it appears, that the dizzinefs felt in the head, after feeing objects in unufual motion, is no other than a continuation of the motions of the optic nerve excited by thofe objects, and which engage our attention. Thus on turning round on one foot, the vertigo continues for fome feconds of time after the perfon is fallen on the ground; and the longer he has continued

continued to revolve, the longer will continue theſe ſucceſſive motions of the parts of the optic nerve.

After revolving with your eyes open till you become vertiginous, as ſoon as you ceaſe to revolve, not only the circum-ambient objects appear to circulate round you in a direction contrary to that, in which you have been turning, but you are liable to roll your eyes forwards and backwards; as is well obſerved, and ingeniouſly demonſtrated by Dr. Wells in a late publication on viſion. The ſame occurs, if you revolve with your eyes cloſed, and open them immediately at the time of your ceaſing to turn; and even during the whole time of revolving, as may be felt by your hand preſſed lightly on your cloſed eyelids. To theſe movements of the eyes, of which he ſuppoſes the obſerver to be inconſcious, Dr. Wells aſcribes the apparent circumgyration of objects on ceaſing to revolve.

The cauſe of thus turning our eyes forwards, and then back again, after our body is at reſt, depends, I imagine, on the ſame circumſtance, which induces us to follow the indiſtinct ſpectra, which are formed on one ſide of the centre of the retina, when we obſerve them apparently on clouds, as deſcribed in Sect. XL. 2. 2; and then not being able to gain a more diſtinct viſion of them, we turn our eyes back, and again and again purſue the flying ſhade.

But

But this rolling of the eyes, after revolving till we become vertiginous, cannot caufe the apparent circumgyration of objects, in a direction contrary to that in which we have been revolving, for the following reafons. 1. Becaufe in purfuing a fpectrum in the fky, or on the ground, as above mentioned, we perceive no retrograde motions of objects. 2. Becaufe the apparent retrograde motions of objects, when we have revolved till we are vertiginous, continues much longer than the rolling of the eyes above defcribed.

3. When we have revolved from right to left, the apparent motion of objects, when we ftop, is from left to right; and when we have revolved from left to right, the apparent circulation of objects is from right to left: yet in both thefe cafes the eyes of the revolver are feen equally to roll forwards and backwards.

4. Becaufe this rolling of the eyes backwards and forwards takes place during our revolving, as may be perceived by the hand lightly preffed on the clofed eyelids, and therefore exifts before the effect afcribed to it.

And fifthly, I now come to relate an experiment, in which the rolling of the eyes does not take place at all after revolving, and yet the vertigo is more diftreffing than in the fituations above mentioned. If any one looks fteadily at a fpot in the ceiling over his head, or indeed at his own finger held up high over his head, and

in that ſituation turns round till he becomes giddy; and then ſtops, and looks horizontally; he now finds, that the apparent rotation of objects is from above downwards, or from below upwards; that is, that the apparent circulation of objects is now vertical inſtead of horizontal, making part of a circle round the axis of his eye; and this without any rolling of his eyeballs. The reaſon of there being no rolling of the eyeballs perceived after this experiment, is, becauſe the images of objects are formed in rotation round the axis of the eye, and not from one ſide to the other of the axis of it; ſo that, as the eyeball has not power to turn in its ſocket round its own axis, it cannot follow the apparent motions of theſe evaneſcent ſpectra, either before or after the body is at reſt. From all which arguments it is manifeſt, that theſe apparent retrograde gyrations of objects are not cauſed by the rolling of the eyeballs; firſt, becauſe no apparent retrogreſſion of objects is obſerved in other rollings of the eyes. Secondly, becauſe the apparent retrogreſſion of objects continues many ſeconds after the rolling of the eyeballs ceaſes. Thirdly, becauſe the apparent retrogreſſion of objects is ſometimes one way, and ſometimes another, yet the rolling of the eyeballs is the ſame. Fourthly, becauſe the rolling of the eyeballs exiſts before the apparent retrograde motions of objects is obſerved; that is, before the revolving perſon ſtops. And fifthly, becauſe the

 apparent

apparent retrograde gyration of objects is produced, when there is no rolling of the eyeballs at all.

Doctor Wells imagines, that no spectra can be gained in the eye, if a person revolves with his eyelids closed, and thinks this a sufficient argument against the opinion, that the apparent progression of the spectra of light or colours in the eye can cause the apparent retrogression of objects in the vertigo above described; but it is certain, when any person revolves in a light room with his eyes closed, that he nevertheless perceives differences of light both in quantity and colour through his eyelids, as he turns round; and readily gains spectra of those differences. And these spectra are not very different except in vivacity from those, which he acquires, when he revolves with unclosed eyes, since if he then revolves very rapidly the colours and forms of surrounding objects are as it were mixed together in his eye; as when the prismatic colours are painted on a wheel, they appear white as they revolve. The truth of this is evinced by the staggering or vertigo of men perfectly blind, when they turn round; which is not attended with apparent circulation of objects, but is a vertiginous disorder of the sense of touch. Blind men balance themselves by their sense of touch; which, being less adapted for perceiving small deviations from their perpendicular, occasions them to carry themselves more erect in walking. This method

of balancing themſelves by the direction of their preſſure againſt the floor, becomes diſordered by the unuſual mode of action in turning round, and they begin to loſe their perpendicularity, that is, they become vertiginous; but without any apparent circular motions of viſible objects.

It will appear from the following experiments, that the apparent progreſſion of the ocular ſpectra of light or colours is the cauſe of the apparent retrogreſſion of objects, after a perſon has revolved, till he is vertiginous.

Firſt, when a perſon turns round in a light room with his eyes open, but cloſes them before he ſtops, he will ſeem to be carried forwards in the direction he was turning for a ſhort time after he ſtops. But if he opens his eyes again, the objects before him inſtantly appear to move in a retrograde direction, and he loſes the ſenſation of being carried forwards. The ſame occurs if a perſon revolves in a light room with his eyes cloſed; when he ſtops, he ſeems to be for a time carried forwards, if his eyes are ſtill cloſed; but the inſtant he opens them, the ſurrounding objects appear to move in retrograde gyration. From hence it may be concluded, that it is the ſenſation or imagination of our continuing to go forwards in the direction in which we were turning, that cauſes the apparent retrograde circulation of objects.

Secondly, though there is an audible vertigo,

as

as is known by the battément, or undulations of ſound in the ears, which many vertiginous people experience; and though there is alſo a tangible vertigo, as when a blind perſon turns round, as mentioned above; yet as this circumgyration of objects is an hallucination or deception of the ſenſe of ſight, we are to look for the cauſe of our appearing to move forward, when we ſtop with our eyes cloſed after gyration, to ſome affection of this ſenſe. Now, thirdly, if the ſpectra formed in the eye during our rotation continue to change, when we ſtand ſtill, like the ſpectra deſcribed in Sect. III. 3. 6. ſuch changes muſt ſuggeſt to us the idea or ſenſation of our ſtill continuing to turn round; as is the caſe, when we revolve in a light room, and cloſe our eyes before we ſtop. And laſtly, on opening our eyes in the ſituation above deſcribed, the objects we chance to view amid theſe changing ſpectra in the eye, muſt ſeem to move in a contrary direction; as the moon ſometimes appears to move retrograde, when ſwift-gliding clouds are paſſing forwards ſo much nearer the eye of the beholder.

To make obſervations on faint ocular ſpectra requires ſome degree of habit, and compoſure of mind, and even patience; ſome of thoſe deſcribed in ſect. XL. were found difficult to ſee, by many, who tried them; now it happens, that the mind, during the confuſion of vertigo, when all the other irritative tribes of motion, as well as thoſe

of viſion, are in ſome degree diſturbed, together with the fear of falling, is in a very unfit ſtate for the contemplation of ſuch weak ſenſations, as are occaſioned by faint ocular ſpectra. Yet after frequently revolving, both with my eyes cloſed, and with them open, and attending to the ſpectra remaining in them, by ſhading the light from my eyelids more or leſs with my hand, I at length ceaſed to have the idea of going forward, after I ſtopped with my eyes cloſed; and ſaw changing ſpectra in my eyes, which ſeemed to move, as it were, over the field of viſion; till at length, by repeated trials on ſunny days, I perſuaded myſelf, on opening my eyes, after revolving ſome time, on a ſhelf of gilded books in my library, that I could perceive the ſpectra in my eyes move forwards over one or two of the books, like the vapours in the air of a ſummer's day; and could ſo far undeceive myſelf, as to perceive the books to ſtand ſtill. After more trials I ſometimes brought myſelf to believe, that I ſaw changing ſpectra of lights and ſhades moving in my eyes, after turning round for ſome time, but did not imagine either the ſpectra or the objects to be in a ſtate of gyration. I ſpeak, however, with diffidence of theſe facts, as I could not always make the experiments ſucceed, when there was not a ſtrong light in my room, or when my eyes were not in the moſt proper ſtate for ſuch obſervations.

The ingenious and learned M. Sauvage has mentioned

mentioned other theories to account for the apparent circumgyration of objects in vertiginous people. As the retrograde motions of the particles of blood in the optic arteries, by ſpaſm, or by fear, as is ſeen in the tails of tadpoles, and membranes between the fingers of frogs. Another cauſe he thinks may be from the librations to one ſide, and to the other, of the cryſtalline lens in the eye, by means of involuntary actions of the muſcles, which conſtitute the ciliary proceſs. Both theſe theories lie under the ſame objection as that of Dr. Wells before mentioned; namely, that the apparent motions of objects, after the obſerver has revolved for ſome time, ſhould appear to vibrate this way and that; and not to circulate uniformly in a direction contrary to that, in which the obſerver had revolved.

M. Sauvage has, laſtly, mentioned the theory of colours left in the eye, which he has termed impreſſions on the retina. He ſays, " Experience teaches us, that impreſſions made on the retina by a viſible object remain ſome ſeconds after the object is removed; as appears from the circle of fire which we ſee, when a fire-ſtick is whirled round in the dark; therefore when we are carried round our own axis in a circle, we undergo a temporary vertigo, when we ſtop; becauſe the impreſſions of the circumjacent objects remain for a time afterwards on the retina." Noſolog. Method. Claſ. VIII. 1. 1. We have before obſerved,

ſerved, that the changes of theſe colours remaining in the eye, evinces them to be motions of the fine terminations of the retina, and not impreſſions on it; as impreſſions on a paſſive ſubſtance muſt either remain, or ceaſe intirely.

Having reperuſed the ingenious Eſſay of Dr. Wells on Single Viſion, and his additional obſervations in the Gentleman's Magazine on the apparent retrogreſſion of objects in vertigo, I am induced to believe, that this apparent retrogreſſion of objects is not always owing to the ſame cauſe.

When a perſon revolves with his eyes cloſed, till he becomes vertiginous, and then ſtands ſtill without opening them, he ſeems for a while to go forward in the ſame direction. This hallucination of his ideas cannot be owing to ocular ſpectra, becauſe, as Dr. Wells obſerves, no ſuch can have been formed; but it muſt ariſe from a ſimilar continuance or repetition of ideas belonging to the ſenſe of touch, inſtead of to the ſenſe of viſion; and ſhould therefore be called a tangible, not a viſual, vertigo. In common language this belief of continuing to revolve for ſome time, after he ſtands ſtill, when a perſon has turned round for a minute in the dark, would be called a deception of imagination.

Now at this time if he opens his eyes upon a gilt book, placed with other books on a ſhelf about the height of his eye, the gilt book ſeems to recede in the contrary direction; though his eyes

eyes are at this time kept quite ſtill, as well as the gilt book. For if his eyes were not kept ſtill, other books would fall on them in ſucceſſion; which, when I repeatedly made the experiment, did not occur; and which thus evinces, that no motion of the eyes is the cauſe of the apparent retroceſſion of the gilt book. Why then does it happen?—Certainly from an hallucination of ideas, or in common language the deception of imagination.

The vertiginous perſon ſtill imagines, that he continues to revolve forwards, after he has opened his eyes; and in conſequence that the objects, which his eyes happen to fall upon, are revolving backward; as they would appear to do, if he was actually turning round with his eyes open. For he has been accuſtomed to obſerve the motions of bodies, whether apparent or real, ſo much more frequently by the eye than by the touch; that the preſent belief of his gyration, occaſioned by the hallucinations of the ſenſe of touch, is attended with ideas of ſuch imagined motions of viſible objects, as have always accompanied his former gyrations, and have thus been aſſociated with the muſcular actions and perceptions of touch, which occurred at the ſame time.

When the remains of colours are ſeen in the eye, they are termed ocular ſpectra; when remaining ſounds are heard in the ear, they may be called auricular murmurs; but when the remain-

ing motions, or ideas, of the ſenſe of touch continue, as in this vertigo of a blind-folded perſon, they have acquired no name, but may be termed evaneſcent titillations, or tangible hallucinations.

Whence I conclude, that vertigo may have for its cauſe either the ocular ſpectra of the ſenſe of viſion, when a perſon revolves with his eyes open; or the auricular murmurs of the ſenſe of hearing, if he is revolved near a caſcade; or the evaneſcent titillations of the ſenſe of touch, if he revolves blindfold. All theſe I ſhould wiſh to call vaniſhing ideas, or ſenſual motions, of thoſe organs of ſenſe; which ideas, or ſenſual motions, have lately been aſſociated in a circle, and therefore for a time continue to be excited. And what are the ideas of colours, when they are excited by imagination or memory, but the repetition of finer ocular ſpectra? What the idea of ſounds, but the repetition of finer auricular murmurs? And what the ideas of tangible objects, but the repetition of finer evaneſcent titillations?

The tangible, and the auricular, and the viſual vertigo, are all perceived by many people for a day or two after long travelling in a boat or coach; the motions of the veſſel, or vehicle, or of the ſurrounding objects, and the noiſe of the wheels and oars, occur at intervals of reverie, or at the commencement of ſleep. See Sect. XX. 5. Theſe ideas, or ſenſual motions, of ſight, of hearing,

and

and of touch, are ſucceeded by the ſame effects as the ocular ſpectra, the auricular murmurs, and the evaneſcent titillations above mentioned; that is, by a kind of vertigo, and cannot in that reſpect be diſtinguiſhed from them. Which is a further confirmation of the truth of the doctrine delivered in Sect. III. of this work, that the colours remaining in the eyes, which are termed ocular ſpectra, are ideas, or ſenſual motions, belonging to the ſenſe of viſion, which for too long a time continue their activity.

Any one, who ſtands alone on the top of a high tower, if he has not been accuſtomed to balance himſelf by objects placed at ſuch diſtances and with ſuch inclinations, begins to ſtagger, and endeavours to recover himſelf by his muſcular feelings. During this time the apparent motion of objects at a diſtance below him is very great, and the ſpectra of theſe apparent motions continue a little time after he has experienced them; and he is perſuaded to incline the contrary way to counteract their effects; and either immediately falls, or applying his hands to the building, uſes his muſcular feelings to preſerve his perpendicular attitude, contrary to the erroneous perſuaſions of his eyes. Whilſt the perſon, who walks in the dark, ſtaggers, but without dizzineſs; for he neither has the ſenſation of moving objects to take off his attention from his muſcular feelings, nor has he the ſpectra of thoſe motions continued on

his

his retina to add to his confusion. It happens indeed sometimes to one standing on a tower, that the idea of his not having room to extend his base by moving one of his feet outwards, when he begins to incline, superadds fear to his other inconveniencies; which like surprise, joy, or any great degree of sensation, enervates him in a moment, by employing the whole sensorial power, and by thus breaking all the associated trains and tribes of motion.

7. The irritative ideas of objects, whilst we are awake, are perpetually present to our sense of sight; as we view the furniture of our rooms, or the ground we tread upon, throughout the whole day without attending to it. And as our bodies are never at perfect rest during our waking hours, these irritative ideas of objects are attended perpetually with irritative ideas of their apparent motions. The ideas of apparent motions are always irritative ideas, because we never attend to them, whether we attend to the objects themselves, or to their real motions, or to neither. Hence the ideas of the apparent motions of objects are a complete circle of irritative ideas, which continue throughout the day.

Also during all our waking hours, there is a perpetual confused sound of various bodies, as of the wind in our rooms, the fire, distant conversations, mechanic business; this continued buzz, as we are seldom quite motionless, changes its

loudness

loudneſs perpetually, like the ſound of a bell; which riſes and falls as long as it continues, and ſeems to pulſate on the ear. This any one may experience by turning himſelf round near a waterfall; or by ſtriking a glaſs bell, and then moving the direction of its mouth towards the ears, or from them, as long as its vibrations continue. Hence this undulation of indiſtinct ſound makes another concomitant circle of irritative ideas, which continues throughout the day.

We hear this undulating ſound, when we are perfectly at reſt ourſelves, from other ſonorous bodies beſides bells; as from two organ-pipes, which are nearly but not quite in uniſon, when they are ſounded together. When a bell is ſtruck, the circular form is changed into an elliptic one; the longeſt axis of which, as the vibrations continue, moves round the periphery of the bell; and when either axis of this ellipſe is pointed towards our ears, the ſound is louder; and leſs when the intermediate parts of the ellipſe are oppoſite to us. The vibrations of the two organ-pipes may be compared to Nonius's rule; the ſound is louder, when they coincide, and leſs at the intermediate times. But, as the ſound of bells is the moſt familiar of thoſe ſounds, which have a conſiderable battement, the vertiginous patients, who attend to the irritative circles of ſounds above deſcribed, generally compare it to the noiſe of bells.

The

The periſtaltic motions of our ſtomach and inteſtines, and the ſecretions of the various glands, are other circles of irritative motions, ſome of them more or leſs complete, according to our abſtinence or ſatiety.

So that the irritative ideas of the apparent motions of objects, the irritative battements of ſounds, and the movements of our bowels and glands, compoſe a great circle of irritative tribes of motion: and when one conſiderable part of this circle of motions becomes interrupted, the whole proceeds in confuſion, as deſcribed in Section XVII. 1. 7. on Catenation of Motions.

8. Hence a violent vertigo, from whatever cauſe it happens, is generally attended with undulating noiſe in the head, perverſions of the motions of the ſtomach and duodenum, unuſual excretion of bile and gaſtric juice, with much pale urine, ſometimes with yellowneſs of the ſkin, and a diſordered ſecretion of almoſt every gland of the body, till at length the arterial ſyſtem is affected, and fever ſucceeds.

Thus bilious vomitings accompany the vertigo occaſioned by the motion of a ſhip; and when the brain is rendered vertiginous by a paralytic affection of any part of the body, a vomiting generally enſues, and a great diſcharge of bile: and hence great injuries of the head from external violence are ſucceeded by bilious vomitings, and ſometimes by abſceſſes of the liver. And hence,

hence, when a patient is inclined to vomit from other causes, as in some fevers, any motions of the attendants in his room, or of himself when he is raised or turned in his bed, presently induces the vomiting by superadding a degree of vertigo.

9. And conversely it is very usual with those, whose stomachs are affected from internal causes, to be afflicted with vertigo, and noise in the head; such is the vertigo of drunken people, which continues, when their eyes are closed, and themselves in a recumbent posture, as well as when they are in an erect posture, and have their eyes open. And thus the irritation of a stone in the bile-duct, or in the ureter, or an inflammation of any of the intestines, are accompanied with vomitings and vertigo.

In these cases the irritative motions of the stomach, which are in general not attended to, become so changed by some unnatural stimulus, as to become uneasy, and excite our sensation or attention. And thus the other irritative trains of motions, which are associated with it, become disordered by their sympathy. The same happens, when a piece of gravel sticks in the ureter, or when some part of the intestinal canal becomes inflamed. In these cases the irritative muscular motions are first disturbed by unusual stimulus, and a disordered action of the sensual motions, or dizziness ensues. While in sea-sickness the disturbance of the irritative sensual motions, as vertigo,

vertigo, precedes; and the diſordered irritative muſcular motions, as thoſe of the ſtomach in vomiting, follow.

10. When theſe irritative motions are diſturbed, if the degree be not very great, the exertion of voluntary attention to any other object, or any ſudden ſenſation, will disjoin theſe new habits of motion. Thus ſome drunken people have become ſober immediately, when any accident has ſtrongly excited their attention; and ſea-ſickneſs has vaniſhed, when the ſhip has been in danger. Hence when our attention to other objects is moſt relaxed, as juſt before we fall aſleep, or between our reveries when awake, theſe irritative ideas of motion and ſound are moſt liable to be perceived; as thoſe, who have been at ſea, or have travelled long in a coach, ſeem to perceive the vibrations of the ſhip, or the rattling of the wheels, at theſe intervals; which ceaſe again, as ſoon as they exert their attention. That is, at thoſe intervals they attend to the apparent motions, and to the battement of ſounds of the bodies around them, and for a moment miſtake them for thoſe real motions of the ſhip, and noiſe of wheels, which they had lately been accuſtomed to: or at theſe intervals of reverie, or on the approach of ſleep, theſe ſuppoſed motions or ſounds may be produced entirely by imagination.

We may conclude from this account of vertigo, that ſea-ſickneſs is not an effort of nature to re-

lieve herſelf, but a neceſſary conſequence of the aſſociations or catenations of animal motions. And may thence infer, that the vomiting, which attends the gravel in the ureter, inflammations of the bowels, and the commencement of ſome fevers, has a ſimilar origin, and is not always an effort of the vis medicatrix naturæ. But where the action of the organ is the immediate conſequence of the ſtimulating cauſe, it is frequently exerted to diſlodge that ſtimulus, as in vomiting up an emetic drug; at other times, the action of an organ is a general effort to relieve pain, as in convulſions of the locomotive muſcles; other actions drink up and carry on the fluids, as in abſorption and ſecretion; all which may be termed efforts of nature to relieve, or to preſerve herſelf.

11. The cure of vertigo will frequently depend on our previouſly inveſtigating the cauſe of it, which from what has been delivered above may originate from the diſorder of any part of the great tribes of irritative motions, and of the aſſociate motions catenated with them.

Many people, when they arrive at fifty or ſixty years of age, are affected with ſlight vertigo; which is generally but wrongly aſcribed to indigeſtion, but in reality ariſes from a beginning defect of their ſight; as about this time they alſo find it neceſſary to begin to uſe ſpectacles, when they read ſmall prints, eſpecially in winter, or by candle light, but are yet able to read without

them during the ſummer days, when the light is ſtronger. Theſe people do not ſee objects ſo diſtinctly as formerly, and by exerting their eyes more than uſual, they perceive the apparent motions of objects, and confound them with the real motions of them; and therefore cannot accurately balance themſelves ſo as eaſily to preſerve their perpendicularity by them.

That is, the apparent motions of objects, which are at reſt, as we move by them, ſhould only excite irritative ideas: but as theſe are now become leſs diſtinct, owing to the beginning imperfection of our ſight, we are induced *voluntarily* to attend to them; and then theſe apparent motions become ſucceeded by ſenſation; and thus the other parts of the trains of irritative ideas, or irritative muſcular motions, become diſordered, as explained above. In theſe caſes of ſlight vertigo I have always promiſed my patients, that they would get free from it in two or three months, as they ſhould acquire the habit of balancing their bodies by leſs diſtinct objects, and have ſeldom been miſtaken in my prognoſtic.

There is an auditory vertigo, which is called a noiſe in the head, explained in No. 7. of this ſection, which alſo is very liable to affect people in the advance of life, and is owing to their hearing leſs perfectly than before. This is ſometimes called a ringing, and ſometimes a ſinging, or buzzing, in the ears, and is occaſioned by our

firſt

firſt experiencing a diſagreeable ſenſation from our not being able diſtinctly to hear the ſounds, we uſed formerly to hear diſtinctly. And this diſagreeable ſenſation excites deſire and conſequent volition; and when we voluntarily attend to ſmall indiſtinct ſounds, even the whiſpering of the air in a room, and the pulſations of the arteries of the ear are ſucceeded by ſenſation; which minute ſounds ought only to have produced irritative ſenſual motions, or unperceived ideas. See Section XVII. 3. 6. Theſe patients after a while loſe this auditory vertigo, by acquiring a new habit of not attending voluntarily to theſe indiſtinct ſounds, but contenting themſelves with the leſs accuracy of their ſenſe of hearing.

Another kind of vertigo begins with the diſordered action of ſome irritative muſcular motions, as thoſe of the ſtomach from intoxication, or from emetics; or thoſe of the ureter, from the ſtimulus of a ſtone lodged in it; and it is probable, that the diſordered motions of ſome of the great congeries of glands, as of thoſe which form the liver, or of the inteſtinal canal, may occaſion vertigo in conſequence of their motions being aſſociated or catenated with the great circles of irritative motions; and from hence it appears, that the means of cure muſt be adapted to the cauſe.

To prevent ſea-ſickneſs it is probable, that the

habit of ſwinging for a week or two before going on ſhipboard might be of ſervice. For the vertigo from failure of ſight, ſpectacles may be uſed. For the auditory vertigo, æther may be dropt into the ear to ſtimulate the part, or to diſſolve ear-wax, if ſuch be a part of the cauſe. For the vertigo ariſing from indigeſtion, the peruvian bark and a bliſter are recommended. And for that owing to a ſtone in the ureter, veneſection, cathartics, opiates, ſal ſoda aerated.

12. Definition of vertigo. 1. Some of the irritative ſenſual, or muſcular motions, which were uſually not ſucceeded by ſenſation, are in this diſeaſe ſucceeded by ſenſation; and the trains or circles of motions, which were uſually catenated with them, are interrupted, or inverted, or proceed in confuſion. 2. The ſenſitive and voluntary motions continue undiſturbed. 3. The aſſociate trains or circles of motions continue; but their catenations with ſome of the irritative motions are diſordered, or inverted, or diſſevered.

## SECT. XXI.

### OF DRUNKENNESS.

*1. Sleep from ſatiety of hunger. From rocking children. From uniform ſounds. 2. Intoxication from common food after fatigue and inanition. 3. From wine or opium. Chilneſs after meals. Vertigo. Why pleaſure is produced by intoxication, and by ſwinging and rocking children. And why pain is relieved by it. 4. Why drunkards ſtagger and ſtammer, and are liable to weep. 5. And become delirious, ſleepy and ſtupid. 6. Or make pale urine and vomit. 7. Objects are ſeen double. 8. Attention of the mind diminiſhes drunkenneſs. 9. Diſordered irritative motions of all the ſenſes. 10. Diſeaſes from drunkenneſs. 11. Definition of drunkenneſs.*

1. IN the ſtate of nature when the ſenſe of hunger is appeaſed by the ſtimulus of agreeable food, the buſineſs of the day is over, and the human ſavage is at peace with the world, he then exerts little attention to external objects, pleaſing reveries of imagination ſucceed, and at length ſleep is the reſult: till the nouriſhment which he has procured, is carried over every part of the ſyſtem to repair the injuries of action, and he awakens with freſh vigour, and feels a renewal of his ſenſe of hunger.

The juices of ſome bitter vegetables, as of the poppy and the laurocerafus, and the ardent ſpirit produced in the fermentation of the ſugar found in vegetable juices, are ſo agreeable to the nerves of the ſtomach, that, taken in a ſmall quantity, they inſtantly pacify the ſenſe of hunger; and the inattention to external ſtimuli with the reveries of imagination, and ſleep, ſucceeds, in the ſame manner as when the ſtomach is filled with other leſs intoxicating food.

This inattention to the irritative motions occaſioned by external ſtimuli is a very important circumſtance in the approach of ſleep, and is produced in young children by rocking their cradles: during which all viſible objects become indiſtinct to them. An uniform ſoft repeated ſound, as the murmurs of a gentle current, or of bees, are ſaid to produce the ſame effect, by preſenting indiſtinct ideas of inconſequential ſounds, and by thus ſtealing our attention from other objects, whilſt by their continued reiterations they become familiar themſelves, and we ceaſe gradually to attend to any thing, and ſleep enſues.

2. After great fatigue or inanition, when the ſtomach is ſuddenly filled with fleſh and vegetable food, the inattention to external ſtimuli, and the reveries of imagination, become ſo conſpicuous as to amount to a degree of intoxication. The ſame is at any time produced by ſuperadding a little wine or opium to our common meals; or by

by taking theſe ſeparately in conſiderable quantity; and this more efficaciouſly after fatigue or inanition; becauſe a leſs quantity of any ſtimulating material will excite an organ into energetic action, after it has lately been torpid from defect of ſtimulus; as objects appear more luminous, after we have been in the dark; and becauſe the ſuſpenſion of volition, which is the immediate cauſe of ſleep, is ſooner induced, after a continued voluntary exertion has in part exhauſted the ſenſorial power of volition; in the ſame manner as we cannot contract a ſingle muſcle long together without intervals of inaction.

3. In the beginning of intoxication we are inclined to ſleep, as mentioned above, but by the excitement of external circumſtances, as of noiſe, light, buſineſs, or by the exertion of volition, we prevent the approaches of it, and continue to take into our ſtomach greater quantities of the inebriating materials. By theſe means the irritative movements of the ſtomach are excited into greater action than is natural; and in conſequence all the irritative tribes and trains of motion, which are catenated with them, become ſuſceptible of ſtronger action from their accuſtomed ſtimuli; becauſe theſe motions are excited both by their uſual irritation, and by their aſſociation with the increaſed actions of the ſtomach and lacteals. Hence the ſkin glows, and the heat of the body

is increaſed, by the more energetic action of the whole glandular ſyſtem; and pleaſure is introduced in conſequence of theſe increaſed motions from internal ſtimulus. According to Law 5. Sect. IV. on Animal Cauſation.

From this great increaſe of irritative motions from internal ſtimulus, and the increaſed ſenſation introduced into the ſyſtem in conſequence; and ſecondly, from the increaſed ſenſitive motions in conſequence of this additional quantity of ſenſation, ſo much ſenſorial power is expended, that the voluntary power becomes feebly exerted, and the irritation from the ſtimulus of external objects is leſs forcible; the external parts of the eye are not therefore voluntarily adapted to the diſtances of objects, whence the apparent motions of thoſe objects either are ſeen double, or become too indiſtinct for the purpoſe of balancing the body, and vertigo is induced.

Hence we become acquainted with that very curious circumſtance, why the drunken vertigo is attended with an increaſe of pleaſure; for the irritative ideas and motions occaſioned by internal ſtimulus, that were not attended to in our ſober hours, are now juſt ſo much increaſed as to be ſucceeded by pleaſurable ſenſation, in the ſame manner as the more violent motions of our organs are ſucceeded by painful ſenſation. And hence a greater quantity of pleaſurable ſenſation

is

is introduced into the conftitution; which is attended in fome people with an increafe of benevolence and good humour.

If the apparent motions of objects is much increafed, as when we revolve on one foot, or are fwung on a rope, the ideas of thefe apparent motions are alfo attended to, and are fucceeded with pleafurable fenfation, till they become familiar to us by frequent ufe. Hence children are at firft delighted with thefe kinds of exercife, and with riding, and failing, and hence rocking young children inclines them to fleep. For though in the vertigo from intoxication the irritative ideas of the apparent motions of objects are indiftinct from their decreafe of energy: yet in the vertigo occafioned by rocking or fwinging the irritative ideas of the apparent motions of objects are increafed in energy, and hence they induce pleafure into the fyftem, but are equally indiftinct, and in confequence equally unfit to balance ourfelves by. This addition of pleafure precludes defire or averfion, and in confequence the voluntary power is feebly exerted, and on this account rocking young children inclines them to fleep.

In what manner opium and wine act in relieving pain is another article, that well deferves our attention. There are many pains that originate from defect as well as from excefs of ftimulus; of thefe are thofe of the fix appetites of hunger,

thirft,

thirst, lust, the want of heat, of distention, and of fresh air. Thus if our cutaneous capillaries cease to act from the diminished stimulus of heat, when we are exposed to cold weather, or our stomach is uneasy for want of food; these are both pains from defect of stimulus, and in consequence opium, which stimulates all the moving system into increased action, must relieve them. But this is not the case in those pains, which arise from excess of stimulus, as in violent inflammations: in these the exhibition of opium is frequently injurious by increasing the action of the system already too great, as in inflammation of the bowels mortification is often produced by the stimulus of opium. Where, however, no such bad consequences follow; the stimulus of opium, by increasing all the motions of the system, expends so much of the sensorial power, that the actions of the whole system soon become feebler, and in consequence those which produced the pain and inflammation.

4. When intoxication proceeds a little further, the quantity of pleasurable sensation is so far increased, that all desire ceases, for there is no pain in the system to excite it. Hence the voluntary exertions are diminished, staggering and stammering succeed; and the trains of ideas become more and more inconsistent from this defect of voluntary exertion, as explained in the sections on sleep and reverie, whilst those passions which

are unmixed with volition are more vividly felt, and ſhewn with leſs reſerve; hence pining love, or ſuperſtitious fear, and the maudling tear dropped on the remembrance of the moſt trifling diſtreſs.

5. At length all theſe circumſtances are increaſed; the quantity of pleaſure introduced into the ſyſtem by the increaſed irritative muſcular motions of the whole ſanguiferous, and glandular, and abſorbent ſyſtems, becomes ſo great, that the organs of ſenſe are more forcibly excited into action by this internal pleaſurable ſenſation, than by the irritation from the ſtimulus of external objects. Hence the drunkard ceaſes to attend to external ſtimuli, and as volition is now alſo ſuſpended, the trains of his ideas become totally inconſiſtent as in dreams, or delirium: and at length a ſtupor ſucceeds from the great exhauſtion of ſenſorial power, which probably does not even admit of dreams, and in which, as in apoplexy, no motions continue but thoſe from internal ſtimuli, from ſenſation, and from aſſociation.

6. In other people a paroxyſm of drunkenneſs has another termination; the inebriate, as ſoon as he begins to be vertiginous, makes pale urine in great quantities and very frequently, and at length becomes ſick, vomits repeatedly, or purges, or has profuſe ſweats, and a temporary fever enſues with a quick ſtrong pulſe. This in ſome hours is ſucceeded by ſleep; but the unfortunate bacchanalian

bacchanalian does not perfectly recover himself till about the same time of the succeeding day, when his course of inebriation began. As shewn in Sect. XVII. 1. 7. on Catenation. The temporary fever with strong pulse is owing to the same cause as the glow on the skin mentioned in the third paragraph of this Section: the flow of urine and sickness arise from the whole system of irritative motions being thrown into confusion by their associations with each other; as in sea-sickness, mentioned in Sect. XX. 4. on Vertigo; and which is more fully explained in Section XXIX. on Diabetes.

7. In this vertigo from internal causes we see objects double, as two candles instead of one, which is thus explained. Two lines drawn through the axes of our two eyes meet at the object we attend to: this angle of the optic axes increases or diminishes with the less or greater distances of objects. All objects before or behind the place where this angle is formed, appear double; as any one may observe by holding up a pen between his eyes and the candle; when he looks attentively at a spot on the pen, and carelessly at the candle, it will appear double; and the reverse when he looks attentively at the candle and carelessly at the pen; so that in this case the muscles of the eye, like those of the limbs, stagger and are disobedient to the expiring efforts of volition. Numerous objects are indeed sometimes

times feen by the inebriate, occafioned by the refractions made by the tears, which ftand upon his eye-lids.

8. This vertigo alfo continues, when the inebriate lies in his bed, in the dark, or with his eyes clofed; and this more powerfully than when he is erect, and in the light. For the irritative ideas of the apparent motions of objects are now excited by irritation from internal ftimulus, or by affociation with other irritative motions; and the inebriate, like one in a dream, believes the objects of thefe irritative motions to be prefent, and feels himfelf vertiginous. I have obferved in this fituation, fo long as my eyes and mind were intent upon a book, the ficknefs and vertigo ceafed, and were renewed again the moment I difcontinued this attention; as was explained in the preceding account of fea-ficknefs. Some drunken people have been known to become fober inftantly from fome accident, that has ftrongly excited their attention, as the pain of a broken bone, or the news of their houfe being on fire.

9. Sometimes the vertigo from internal caufes, as from intoxication, or at the beginning of fome fevers, becomes fo univerfal, that the irritative motions which belong to other organs of fenfe are fucceeded by fenfation or attention, as well as thofe of the eye. The vertiginous noife in the ears has been explained in Section XX. on Vertigo. The tafte of the faliva, which in general is

not

not attended to, becomes perceptible, and the patients complain of a bad taſte in their mouth.

The common ſmells of the ſurrounding air ſometimes excite the attention of theſe patients, and bad ſmells are complained of, which to other people are imperceptible. The irritative motions that belong to the ſenſe of preſſure, or of touch, are attended to, and the patient conceives the bed to librate, and is fearful of falling out of it. The irritative motions belonging to the ſenſes of diſtention, and of heat, like thoſe above mentioned, become attended to at this time: hence we feel the pulſation of our arteries all over us, and complain of heat, or of cold, in parts of the body where there is no accumulation or diminution of actual heat. All which are to be explained, as in the laſt paragraph, by the irritative ideas belonging to the various ſenſes being now excited by internal ſtimuli, or by their aſſociations with other irritative motions. And that the inebriate, like one in a dream, believes the external objects, which uſually cauſed theſe irritative ideas, to be now preſent.

10. The diſeaſes in conſequence of frequent inebriety, or of daily taking much vinous ſpirit without inebriety, conſiſt in the paralyſis, which is liable to ſucceed violent ſtimulation. Organs, whoſe actions are aſſociated with others, are frequently more affected than the organ, which is ſtimulated into too violent action. See Sect. XXIV.

XXIV. 2. 8. Hence in drunken people it generally happens, that the ſecretory veſſels of the liver become firſt paralytic, and a torpor with conſequent gall-ſtones or ſcirrhus of this viſcus is induced with concomitant jaundice; otherwiſe it becomes inflamed in conſequence of previous torpor, and this inflammation is frequently transferred to a more ſenſible part, which is aſſociated with it, and produces the gout, or the roſy eruption of the face, or ſome other leprous eruption on the head, or arms, or legs. Sometimes the ſtomach is firſt affected, and paralyſis of the lacteal ſyſtem is induced: whence a total abhorrence from fleſh-food, and general emaciation. In others the lymphatic ſyſtem is affected with paralyſis, and dropſy is the conſequence. In ſome inebriates the torpor of the liver produces pain without apparent ſcirrhus, or gall-ſtones, or inflammation, or conſequent gout, and in theſe epilepſy or inſanity are often the conſequence. All which will be more fully treated of in the courſe of the work.

I am well aware, that it is a common opinion, that the gout is as frequently owing to gluttony in eating, as to intemperance in drinking fermented or ſpirituous liquors. To this I anſwer, that I have ſeen no perſon afflicted with the gout, who has not drunk freely of fermented liquor, as wine and water, or ſmall beer; though as the diſpoſition to all the diſeaſes, which have originated from

from intoxication, is in ſome degree hereditary, a leſs quantity of ſpirituous potation will induce the gout in theſe, who inherit the diſpoſition from their parents. To which I muſt add, that in young people the rheumatiſm is frequently miſtaken for the gout.

Spice is ſeldom taken in ſuch quantity as to do any material injury to the ſyſtem, fleſh-meats as well as vegetables are the natural diet of mankind; with theſe a glutton may be crammed up to the throat, and fed fat like a ſtalled ox; but he will not be diſeaſed, unleſs he adds ſpirituous or fermented liquor to his food. This is well known in the diſtilleries, where the ſwine, which are fattened by the ſpirituous ſediments of barrels, acquire diſeaſed livers. But mark what happens to a man, who drinks a quart of wine or of ale, if he has not been habituated to it. He loſes the uſe of both his limbs and of his underſtanding! He becomes a temporary idiot, and has a temporary ſtroke of the palſy! And though he ſlowly recovers after ſome hours, is it not reaſonable to conclude, that a perpetual repetition of ſo powerful a poiſon muſt at length permanently affect him?—If a perſon accidentally becomes intoxicated by eating a few muſhrooms of a peculiar kind, a general alarm is excited, and he is ſaid to be poiſoned, and emetics are exhibited; but ſo familiariſed are we to the intoxication from vinous ſpirit, that it occaſions laughter rather than alarm.

There

There is however confiderable danger in too haftily difcontinuing the ufe of fo ftrong a ftimulus, left the torpor of the fyftem, or paralyfis, fhould fooner be induced by the omiffion than by the continuance of this habit, when unfortunately acquired. A golden rule for determining the quantity, which may with fafety be difcontinued, is delivered in Sect. XII. 7. 8.

11. Definition of drunkennefs. Many of the irritative motions are much increafed in energy by internal ftimulation.

2. A great additional quantity of pleafurable fenfation is occafioned by this increafed exertion of the irritative motions. And many fenfitive motions are produced in confequence of this increafed fenfation.

3. The affociated trains and tribes of motions, catenated with the increafed irritative and fenfitive motions, are difturbed, and proceed in confufion.

4. The faculty of volition is gradually impaired, whence proceeds the inftability of locomotion, inaccuracy of perception, and inconfiftency of ideas; and is at length totally fufpended, and a temporary apoplexy fucceeds.

# SECT. XXII.

## OF PROPENSITY TO MOTION, REPETITION AND IMITATION.

I. *Accumulation of ſenſorial power in hemiplegia, in ſleep, in cold fit of fever, in the locomotive muſcles, in the organs of ſenſe. Produces propenſity to action.* II. *Repetition by three ſenſorial powers. In rhimes and alliterations, in muſic, dancing, architecture, landſcape-painting, beauty.* III. 1. *Perception conſiſts in imitation. Four kinds of imitation.* 2. *Voluntary. Dogs taught to dance.* 3. *Senſitive. Hence ſympathy, and all our virtues. Contagious matter of venereal ulcers, of hydrophobia, of jail-fever, of ſmall-pox, produced by imitation, and the ſex of the embryon.* 4. *Irritative imitation.* 5. *Imitations reſolvable into aſſociations.*

I. 1. In the hemiplegia, when the limbs on one ſide have loſt their power of voluntary motion, the patient is for many days perpetually employed in moving thoſe of the other. 2. When the voluntary power is ſuſpended during ſleep, there commences a ceaſeleſs flow of ſenſitive motions, or ideas of imagination, which compoſe our dreams. 3. When in the cold fit of an intermittent fever ſome parts of the ſyſtem have for a time continued torpid, and have thus expended leſs than

than their ufual expenditure of fenforial power; a hot fit fucceeds, with violent action of thofe veffels, which had previoufly been quiefcent. All thefe are explained from an accumulation of fenforial power during the inactivity of fome part of the fyftem.

Befides the very great quantity of fenforial power perpetually produced and expended in moving the arterial, venous, and glandular fyftems, with the various organs of digeftion, as defcribed in Section XXXII. 3. 2. there is alfo a conftant expenditure of it by the action of our locomotive mufcles and organs of fenfe. Thus the thicknefs of the optic nerves, where they enter the eye, and the great expanfion of the nerves of touch beneath the whole of the cuticle, evince the great confumption of fenforial power by thefe fenfes. And our perpetual mufcular actions in the common offices of life, and in conftantly preferving the perpendicularity of our bodies during the day, evince a confiderable expenditure of the fpirit of animation by our locomotive mufcles. It follows that if the exertion of thefe organs of fenfe and mufcles be for a while intermitted, that fome quantity of fenforial power muft be accumulated, and a propenfity to activity of fome kind enfue from the increafed excitability of the fyftem. Whence proceeds the irkfomenefs of a continued attitude, and of an indolent life.

However ſmall this hourly accumulation of the ſpirit of animation may be, it produces a propenſity to ſome kind of action; but it nevertheleſs requires either deſire or averſion, either pleaſure or pain, or ſome external ſtimulus, or a previous link of aſſociation, to excite the ſyſtem into activity; thus it frequently happens, when the mind and body are ſo unemployed as not to poſſeſs any of the three firſt kinds of ſtimuli, that the laſt takes place, and conſumes the ſmall but perpetual accumulation of ſenſorial power. Whence ſome indolent people repeat the ſame verſe for hours together, or hum the ſame tune. Thus the poet:

> Onward he trudged, not knowing what he ſought,
> And whiſtled as he went, for want of thought.

II. The repetitions of motions may be at firſt produced either by volition, or by ſenſation, or by irritation, but they ſoon become eaſier to perform than any other kinds of action, becauſe they ſoon become aſſociated together, according to Law the ſeventh, Section IV. on Animal Cauſation. And becauſe their frequency of repetition, if as much ſenſorial power be produced during every reiteration as is expended, adds to the facility of their production.

If a ſtimulus be repeated at uniform intervals of time, as deſcribed in Sect. XII. 3. 3. the action, whether of our muſcles or organs of ſenſe, is

is produced with ſtill greater facility or energy; becauſe the ſenſorial power of aſſociation, mentioned above, is combined with the ſenſorial power of irritation; that is, in common language, the acquired habit aſſiſts the power of the ſtimulus.

This not only obtains in the annual, lunar, and diurnal catenations of animal motions, as explained in Sect. XXXVI. which are thus performed with great facility and energy; but in every leſs circle of actions or ideas, as in the burthen of a ſong, or the reiterations of a dance. To the facility and diſtinctneſs, with which we hear ſounds at repeated intervals, we owe the pleaſure, which we receive from muſical time, and from poetic time; as deſcribed in Botanic Garden, P. 2. Interlude 3. And to this the pleaſure we receive from the rhimes and alliterations of modern verſification; the ſource of which without this key would be difficult to diſcover. And to this likewiſe ſhould be aſcribed the beauty of the duplicature in the perfect tenſe of the Greek verbs, and of ſome Latin ones, as tango tetegi, mordeo momordi.

There is no variety of notes referable to the gamut in the beating of the drum, yet if it be performed in muſical time, it is agreeable to our ears; and therefore this pleaſurable ſenſation muſt be owing to the repetition of the diviſions of the ſounds at certain intervals of time, or muſical

 bars.

bars. Whether these times or bars are distinguish-ed by a pause, or by an emphasis, or accent, certain it is, that this distinction is perpetually repeated; otherwise the ear could not determine instantly, whether the successions of sound were in common or in triple time. In common time there is a division between every two crotchets, or other notes of equivalent time; though the bar in written music is put after every fourth crotchet, or notes equivalent in time; in triple time the division or bar is after every three crotchets, or notes equivalent; so that in common time the repetition recurs more frequently than in triple time. The grave or heroic verses of the Greek and Latin poets are written in common time; the French heroic verses, and Mr. Anstie's humorous verses in his Bath Guide, are written in the same time as the Greek and Latin verses, but are one bar shorter. The English grave or heroic verses are measured by triple time, as Mr. Pope's translation of Homer.

But besides these little circles of musical time, there are the greater returning periods, and the still more distant chorusses, which, like the rhimes at the ends of verses, owe their beauty to repetition; that is, to the facility and distinctness with which we perceive sounds, which we expect to perceive, or have perceived before; or in the language of this work, to the greater ease and energy with which our organ is excited by the

combined

combined ſenſorial powers of aſſociation and irritation, than by the latter ſingly.

A certain uniformity or repetition of parts enters the very compoſition of harmony. Thus two octaves neareſt to each other in the ſcale commence their vibrations together after every ſecond vibration of the higher one. And where the firſt, third, and fifth compoſe a chord the vibrations concur or coincide frequently, though leſs ſo than in the two octaves. It is probable that theſe chords bear ſome analogy to a mixture of three alternate colours in the ſun's ſpectrum ſeparated by a priſm.

The pleaſure we receive from a melodious ſucceſſion of notes referable to the gamut is derived from another ſource, viz. to the pandiculation or counteraction of antagoniſt fibres. See Botanic Garden, P. 2. Interlude 3. If to theſe be added our early aſſociations of agreeable ideas with certain proportions of ſound, I ſuppoſe, from theſe three ſources ſprings all the delight of muſic, ſo celebrated by ancient authors, and ſo enthuſiaſtically cultivated at preſent. See Sect. XVI. No. 10. on Inſtinct.

This kind of pleaſure ariſing from repetition, that is from the facility and diſtinctneſs, with which we perceive and underſtand repeated ſenſations, enters into all the agreeable arts; and when it is carried to exceſs is termed formality. The art of dancing like that of muſic depends

for a great part of the pleafure, it affords, on repetition; architecture, efpecially the Grecian, confifts of one part being a repetition of another; and hence the beauty of the pyramidal outline in landfcape-painting; where one fide of the picture may be faid in fome meafure to balance the other. So univerfally does repetition contribute to our pleafure in the fine arts, that beauty itfelf has been defined by fome writers to confift in a due combination of uniformity and variety. See Sect. XVI. 6.

III. 1. Man is termed by Ariftotle an imitative animal; this propenfity to imitation not only appears in the actions of children, but in all the cuftoms and fafhions of the world: many thoufands tread in the beaten paths of others, for one who traverfes regions of his own difcovery. The origin of this propenfity of imitation has not, that I recollect, been deduced from any known principle; when any action prefents itfelf to the view of a child, as of whetting a knife, or threading a needle, the parts of this action in refpect of time, motion, figure, are imitated by a part of the retina of his eye; to perform this action therefore with his hands is eafier to him than to invent any new action, becaufe it confifts in repeating with another fet of fibres, viz. with the moving mufcles, what he had juft performed by fome parts of the retina; juft as in dancing we transfer the times of motion from the actions of

the auditory nerves to the mufcles of the limbs. Imitation therefore confifts of repetition, which we have fhewn above to be the eafieft kind of animal action, and which we perpetually fall into, when we poffefs an accumulation of fenforial power, which is not otherwife called into exertion.

It has been fhewn, that our ideas are configurations of the organs of fenfe, produced originally in confequence of the ftimulus of external bodies. And that thefe ideas, or configurations of the organs of fenfe, refemble in fome property a correfpondent property of external matter; as the parts of the fenfes of fight and of touch, which are excited into action, refemble in figure the figure of the ftimulating body; and probably alfo the colour, and the quantity of denfity, which they perceive. As explained in Sect. XIV. 2. 2. Hence it appears, that our perceptions themfelves are copies, that is, imitations of fome properties of external matter; and the propenfity to imitation is thus interwoven with our exiftence, as it is produced by the ftimuli of external bodies, and is afterwards repeated by our volitions and fenfations, and thus conftitutes all the operations of our minds.

2. Imitations refolve themfelves into four kinds, voluntary, fenfitive, irritative, and affociate. The voluntary imitations are, when we imitate deliberately the actions of others, either by mimicry,

ry, as in acting a play, or in delineating a flower; or in the common actions of our lives, as in our drefs, cookery, language, manners, and even in our habits of thinking.

Not only the greateft part of mankind learn all the common arts of life by imitating others, but brute animals feem capable of acquiring knowledge with greater facility by imitating each other, than by any methods by which we can teach them; as dogs and cats, when they are fick, learn of each other to eat grafs; and I fuppofe, that by making an artificial dog perform certain tricks, as in dancing on his hinder legs, a living dog might be eafily induced to imitate them; and that the readieft way of inftructing dumb animals is by practifing them with others of the fame fpecies, which have already learned the arts we wifh to teach them. The important ufe of imitation in acquiring natural language is mentioned in Section XVI. 7. and 8. on Inftinct.

3. The fenfitive imitations are the immediate confequences of pleafure or pain, and thefe are often produced even contrary to the efforts of the will. Thus many young men on feeing cruel furgical operations become fick, and fome even feel pain in the parts of their own bodies, which they fee tortured or wounded in others; that is, they in fome meafure imitate by the exertions of their own fibres the violent actions, which they witneffed in thofe of others. In this cafe a double

imitation

imitation takes place, firſt the obſerver imitates with the extremities of the optic nerve the mangled limbs, which are preſent before his eyes; then by a ſecond imitation he excites ſo violent action of the fibres of his own limbs as to produce pain in thoſe parts of his own body, which he ſaw wounded in another. In theſe pains produced by imitation the effect has ſome ſimilarity to the cauſe, which diſtinguiſhes them from thoſe produced by aſſociation; as the pains of the teeth, called tooth-edge, which are produced by aſſociation with diſagreeable ſounds, as explained in Sect. XVI. 10.

The effect of this powerful agent, imitation, in the moral world, is mentioned in Sect. XVI. 7. as it is the foundation of all our intellectual ſympathies with the pains and pleaſures of others, and is in conſequence the ſource of all our virtues. For in what conſiſts our ſympathy with the miſeries, or with the joys, of our fellow creatures, but in an involuntary excitation of ideas in ſome meaſure ſimilar or imitative of thoſe, which we believe to exiſt in the minds of the perſons, whom we commiſerate or congratulate?

There are certain concurrent or ſucceſſive actions of ſome of the glands, or other parts of the body, which are poſſeſſed of ſenſation, which become intelligible from this propenſity to imitation. Of theſe are the production of matter by the membranes of the fauces, or by the ſkin, in

conſequence

confequence of the venereal difeafe previoufly affecting the parts of generation. Since as no fever is excited, and as neither the blood of fuch patients, nor even the matter from ulcers of the throat, or from cutaneous ulcers, will by inoculation produce the venereal difeafe in others, as obferved by Mr. Hunter, there is reafon to conclude, that no contagious matter is conveyed thither by the blood-veffels, but that a milder matter is formed by the actions of the fine veffels in thofe membranes imitating each other. See Section XXXIII. 2. 9. In this difeafe the actions of thefe veffels producing ulcers on the throat and fkin are imperfect imitations of thofe producing chancre, or gonorrhœa; fince the matter produced by them is not infectious, while the imitative actions in the hydrophobia appear to be perfect refemblances, as they produce a material equally infectious with the original one, which induced them.

The contagion from the bite of a mad dog differs from other contagious materials, from its being communicable from other animals to mankind, and from many animals to each other; the phenomena attending the hydrophobia are in fome degree explicable on the foregoing theory. The infectious matter does not appear to enter the circulation, as it cannot be traced along the courfe of the lymphatics from the wound, nor is there any fwelling of the lymphatic glands,

nor

nor does any fever attend, as occurs in the small-pox, and in many other contagious diseases; yet by some unknown process the disease is communicated from the wound to the throat, and that many months after the injury, so as to produce pain and hydrophobia, with a secretion of infectious saliva of the same kind, as that of the mad dog, which inflicted the wound.

This subject is very intricate.—It would appear, that by certain morbid actions of the salivary glands of the mad dog, a peculiar kind of saliva is produced; which being instilled into a wound of another animal stimulates the cutaneous or mucous glands into morbid actions, but which are ineffectual in respect to the production of a similar contagious material; but the salivary glands by irritative sympathy are thrown into similar action, and produce an infectious saliva similar to that instilled into the wound.

Though in many contagious fevers a material similar to that which produced the disease, is thus generated by imitation; yet there are other infectious materials, which do not thus propagate themselves, but which seem to act like slow poisons. Of this kind was the contagious matter, which produced the jail-fever at the assizes at Oxford about a century ago. Which, though fatal to so many, was not communicated to their nurses or attendants. In these cases, the imitations of the fine vessels, as above described, ap-

pear

pear to be imperfect, and do not therefore produce a matter ſimilar to that, which ſtimulates them; in this circumſtance reſembling the venereal matter in ulcers of the throat or ſkin, according to the curious diſcovery of Mr. Hunter above related, who found, by repeated inoculations, that it would not infect. Hunter on Venereal Diſeaſe, Part vi. ch. 1.

Another example of morbid imitation is in the production of a great quantity of contagious matter, as in the inoculated ſmall-pox, from a ſmall quantity of it inſerted into the arm. Theſe particles of contagious matter ſtimulate the extremities of the fine arteries of the ſkin, and cauſe them to imitate the motions by which themſelves were produced, and thus to produce a thouſand-fold of a ſimilar material. As different kinds of light may be ſuppoſed to ſtimulate parts of the retina into different kinds of motion, ſo the application of different contagious matters may be believed to ſtimulate the fine terminations of the arteries into different kinds of motion, which may form matters ſimilar to themſelves. This is truly difficult to underſtand, but may be conceived to depend on this circumſtance; that thoſe matters, which ſtimulate other bodies into action, and the bodies thus ſtimulated, muſt poſſeſs ſome common properties, as ſpoken of in Sect. XIV. 4. See Sect. XXXIII. 2. 6. Other inſtances are mentioned in the Section on Generation, which

which ſhew the probability, that the extremities of the ſeminal glands may imitate certain ideas of the mind, or actions of the organs of ſenſe, and thus occaſion the male or female ſex of the embryon. See Sect. XXXIX. 6.

4. We come now to thoſe imitations, which are not attended with ſenſattion. Of theſe are all the irritative ideas already explained, as when the retina of the eye imitates by its action or configuration the tree or the bench, which I ſhun in walking paſt without attending to them. Other examples of theſe irritative imitations are daily obſervable in common life; thus one yawning perſon ſhall ſet a whole company a yawning; and ſome have acquired winking of the eyes or impediments of ſpeech by imitating their companions without being conſcious of it.

5. Beſides the three ſpecies of imitations above deſcribed there may be ſome aſſociate motions, which may imitate each other in the kind as well as in the quantity of their action; but it is difficult to diſtinguiſh them from the aſſociations of motions treated of in Section XXXV. Where the actions of other perſons are imitated there can be no doubt, or where we imitate a preconceived idea by exertion of our locomotive muſcles, as in painting a dragon; all theſe imitations may aptly be referred to the ſources above deſcribed of the propenſity to activity, and the facility of repetition; at the ſame time I do not af-

firm, that all thofe other apparent fenfitive and irritative imitations may not be refolvable into affociations of a peculiar kind, in which certain diftant parts of fimilar irritability or fenfibility, and which have habitually acted together, may affect each other exactly with the fame kinds of motion ; as many parts are known to fympathife in the quantity of their motions. And that therefore they may be ultimately refolvable into affociations of action, as defcribed in Sect. XXXV.

## SECT. XXIII.

### OF THE CIRCULATORY SYSTEM.

I. *The heart and arteries have no antagoniſt muſcles. Veins abſorb the blood, propel it forwards, and diſtend the heart; contraction of the heart diſtends the arteries. Vena portarum.* II. *Glands which take their fluids from the blood. With long necks, with ſhort necks.* III. *Abſorbent ſyſtem.* IV. *Heat given out from glandular ſecretions. Blood changes colour in the lungs and in the glands and capillaries.* V. *Blood is abſorbed by veins, as chyle by lacteal veſſels, otherwiſe they could not join their ſtreams.* VI. *Two kinds of ſtimulus, agreeable and diſagreeable. Glandular appetency. Glands originally poſſeſſed ſenſation.*

I. 1. We now ſtep forwards to illuſtrate ſome of the phænomena of diſeaſes, and to trace out their moſt efficacious methods of cure; and ſhall commence the ſubject with a ſhort deſcription of the circulatory ſyſtem.

As the nerves, whoſe extremities form our various organs of ſenſe and muſcles, are all joined, or communicate, by means of the brain, for the convenience perhaps of the diſtribution of a ſubtile ethereal fluid for the purpoſe of motion; ſo all thoſe veſſels of the body, which carry the

groffer fluids for the purpofes of nutrition, communicate with each other by the heart.

The heart and arteries are hollow mufcles, and are therefore indued with power of contraction in confequence of ftimulus, like all other mufcular fibres; but, as they have no antagonift mufcles, the cavities of the veffels, which they form, would remain for ever clofed, after they have contracted themfelves, unlefs fome extraneous power be applied to again diftend them. This extraneous power in refpect to the heart is the current of blood, which is perpetually abforbed by the veins from the various glands and capillaries, and pufhed into the heart by a power probably very fimilar to that, which raifes the fap in vegetables in the fpring, which, according to Dr. Hale's experiment on the ftump of a vine, exerted a force equal to a column of water above twenty feet high. This force of the current of blood in the veins is partly produced by their abforbent power, exerted at the beginning of every fine ramification; which may be conceived to be a mouth abforbing blood, as the mouths of the lacteals and lymphatics abforb chyle and lymph. And partly by their intermitted compreffion by the pulfations of their generally concomitant arteries; by which the blood is perpetually propelled towards the heart, as the valves in many veins, and the abforbent mouths in them all, will not fuffer it to return.

The

The blood, thus forcibly injected into the chambers of the heart, diftends this combination of hollow mufcles; till by the ftimulus of diftention they contract themfelves; and, pufhing forwards the blood into the arteries, exert fufficient force to overcome in lefs than a fecond of time the vis inertiæ, and perhaps fome elafticity, of the very extenfive ramifications of the two great fyftems of the aortal and pulmonary arteries. The power neceffary to do this in fo fhort a time muft be confiderable, and has been varioufly eftimated by different phyfiologifts.

The mufcular coats of the arterial fyftem are then brought into action by the ftimulus of diftention, and propel the blood to the mouths, or through the convolutions, which precede the fecretory apertures of the various glands and capillaries.

In the veffels of the liver there is no intervention of the heart; but the vena portarum, which does the office of an artery, is diftended by the blood poured into it from the mefenteric veins, and is by this diftention ftimulated to contract itfelf, and propel the blood to the mouths of the numerous glands, which compofe that vifcus.

The power of abforption in vegetable roots was fhewn by the experiments of Dr. Hales on vine-ftumps to be equal to the preffure of thirty-eight inches of quickfilver. Veg. Staticks, p. 107. and from the experiments of Mr. Cooper, who

tied the thoracic ducts of living dogs, it appeared, that the abſorbent power of the lacteals and lymphatics always burſt the receptaculum chyli. Mr. Cooper adds, "The contractile powers of the abſorbents are proved by theſe experiments to be very ſtrong; for it appears, that their action is ſufficient to occaſion a rupture of their coats. It is true, that the receptaculum chyli, which was the part broken, is thinner and leſs capable of reſiſtance than the thoracic duct; yet it is able to bear the preſſure of a column of quickſilver more than two feet in height. The force therefore exerted by the abſorbents muſt be acknowledged to be greater than that of ſuch a column of mercury; more eſpecially when it is remembered, that living parts will reſiſt a force, which will readily tear them when dead." Medical Reſearches. London, 1798, p. 110.

Dr. Hales made experiments ſimilar to thoſe on the ſtumps of vines above mentioned, by opening the crural arteries of a horſe, a dog, and a fallow deer, by applying mercurial gauges to meaſure the projectile impetus of their blood; and found that of the vine-ſtump to be five times greater than the force of the blood in the great crural artery of a horſe, ſeven times greater than that of a dog, and eight times greater than that of a fallow d ·e.

The power of abſorption in the animal ſyſtem exerts a force ſuperior to that of the heart, though perhaps

perhaps with lefs velocity; and thus removes all difficulty of accounting for the circulation in the veins and abforbents; and confequently of the circulation in the aortal arteries of fifh, and in the vena portarum, or the bile-fecreting artery of the liver of quadrupeds.

II. 1. The glandular fyftem of veffels may be divided into thofe, which take fome fluid from the circulation; and thofe, which give fomething to it. Thofe, which take their fluid from the circulation, are the various glands, by which the tears, bile, urine, perfpiration, and many other fecretions are produced; thefe glands probably confift of a mouth to felect, a belly to digeft, and an excretory aperture to emit their appropriated fluids; the blood is conveyed by the power of the heart and arteries to the mouths of thefe glands, it is there taken up by the living power of the gland, and carried forwards to its belly, and excretory aperture, where a part is feparated, and the remainder abforbed by the veins for further purpofes.

Some of thefe glands are furnifhed with long convoluted necks or tubes, as the feminal ones, which are curioufly feen when injected with quickfilver. Others feem to confift of fhorter tubes, as that great congeries of glands, which conftitute the liver, and thofe of the kidneys. Some have their excretory apertures opening into refervoirs, as the urinary and gall-bladders. And

others on the external body, as thoſe which ſecrete the tears, and perſpirable matter.

Another great ſyſtem of glands, which have very ſhort necks, are the capillary veſſels; by which the inſenſible perſpiration is ſecreted on the ſkin; and the mucus of various conſiſtences, which lubricates the interſtices of the cellular membrane, of the muſcular fibres, and of all the larger cavities of the body. From the want of a long convolution of veſſels ſome have doubted, whether theſe capillaries ſhould be conſidered as glands, and have been led to conclude, that the perſpirable matter rather exuded than was ſecreted. But the fluid of perſpiration is not ſimple water, though that part of it, which exhales into the air may be ſuch; for there is another part of it, which in a ſtate of health is abſorbed again; but which, when the abſorbents are diſeaſed, remains on the ſurface of the ſkin, in the form of ſcurf, or indurated mucus. Another thing, which ſhews their ſimilitude to other glands, is their ſenſibility to certain affections of the mind; as is ſeen in the deeper colour of the ſkin in the bluſh of ſhame, or the greater paleneſs of it from fear.

III. Another ſeries of glandular veſſels is called the abſorbent ſyſtem; theſe open their mouths into all the cavities, and upon all thoſe ſurfaces of the body, where the excretory apertures of the other glands pour out their fluids. The mouths of the abſorbent ſyſtem drink up a part

or the whole of theſe fluids, and carry them forwards by their living power to their reſpective glands, which are called conglobate glands. There theſe fluids undergo ſome change, before they paſs on into the circulation; but if they are very acrid, the conglobate gland ſwells, and ſometimes ſuppurates, as in inoculation of the ſmall-pox, in the plague, and in venereal abſorptions; at other times the fluid may perhaps continue there, till it undergoes ſome chemical change, that renders it leſs noxious; or, what is more likely, till it is regurgitated by the retrograde motion of the gland in ſpontaneous ſweats or diarrhœas, as diſagreeing food is vomited from the ſtomach.

The powers of abſorption are ſhewn in No. I. of this Section, both thoſe of the blood and of the chyle of animals, and of the ſap-juice of vegetables, to be much greater than has commonly been conceived. To which may be added, that the moving force of the chyle in the receptaculum chyli and thoracic duct muſt be equal to the moving force of the blood in the ſubclavian vein, as otherwiſe the chyle could not enter into that vein, unleſs it be ſuppoſed to poſſeſs a ſyſtole and diaſtole near the heart; which alſo affords an argument to ſhew, that the progreſs of the blood in the veins, and that of the chyle in the abſorbent ſyſtem, originates from a ſimilar cauſe, that of their abſorptive powers.

IV. As all the fluids, that paſs through theſe

glands, and capillary veſſels, undergo a chemical change, acquiring new combinations, the matter of heat is at the ſame time given out; this is apparent, ſince whatever increaſes inſenſible perſpiration, increaſes the heat of the ſkin; and when the action of theſe veſſels is much increaſed but for a moment, as in bluſhing, a vivid heat on the ſkin is the immediate conſequence. So when great bilious ſecretions, or thoſe of any other gland, are produced, heat is generated in the part in proportion to the quantity of the ſecretion.

The heat produced on the ſkin by bluſhing may be thought by ſome too ſudden to be pronounced a chemical effect, as the fermentations or new combinations taking place in a fluid is in general a ſlower proceſs. Yet are there many chemical mixtures in which heat is given out as inſtantaneouſly; as in ſolutions of metals in acids, or in mixtures of eſſential oils and acids, as of oil of cloves and acid of nitre. So the bruiſed parts of an unripe apple become almoſt inſtantaneouſly ſweet; and if the chemico-animal proceſs of digeſtion be ſtopped for but a moment, as by fear, or even by voluntary eructation, a great quantity of air is generated, by the fermentation, which inſtantly ſucceeds the ſtop of digeſtion. By the experiments of Dr. Hales it appears, that an apple during fermentation gave up above ſix hundred times its bulk of air; and the materials in the ſtomach are ſuch, and in ſuch a ſituation, as immediately to run into fermentation, when digeſtion is impeded.

As the blood paſſes through the ſmall veſſels of the lungs, which connect the pulmonary artery and vein, it undergoes a change of colour from a dark to a light red; which may be termed a chemical change, as it is known to be effected by an admixture of oxygene, or vital air; which, according to a diſcovery of Dr. Prieſtley, paſſes through the moiſt membranes, which conſtitute the ſides of theſe veſſels. As the blood paſſes through the capillary veſſels, and glands, which connect the aorta and its various branches with their correſpondent veins in the extremities of the body, it again loſes the bright red colour, and undergoes ſome new combinations in the glands or capillaries, in which the matter of heat is given out from the ſecreted fluids. This proceſs therefore, as well as the proceſs of reſpiration, has ſome analogy to combuſtion, as the vital air or oxygene ſeems to become united to ſome inflammable baſe, and the matter of heat eſcapes from the new acid, which is thus produced.

V. After the blood has paſſed theſe glands and capillaries, and parted with whatever they choſe to take from it, the remainder is received by the veins, which are a ſet of blood-abſorbing veſſels in general correſponding with the ramifications of the arterial ſyſtem. At the extremity of the fine convolutions of the glands the arterial force ceaſes; this, in reſpect to the capillary veſſels, which unite the extremities of the arteries with

with the commencement of the veins, is evident to the eye, on viewing the tail of a tadpole by means of a folar, or even by a common microfcope, for globules of blood are feen to endeavour to pafs, and to return again and again, before they become abforbed by the mouths of the veins; which returning of thefe globules evinces, that the arterial force behind them has ceafed. The veins are furnifhed with valves like the lymphatic abforbents; and the great trunks of the veins, and of the lacteals and lymphatics, join together before the ingrefs of their fluids into the left chamber of the heart; both which evince, that the blood in the veins, and the lymph and chyle in the lacteals and lymphatics, are carried on by a fimilar force; otherwife the ftream, which was propelled with a lefs power, could not enter the veffels, which contained the ftream propelled with a greater power. From whence it appears, that the veins are a fyftem of veffels abforbing blood, as the lacteals and lymphatics are a fyftem of veffels abforbing chyle and lymph. See Sect. XXVII. 1.

VI. The movements of their adapted fluids in the various veffels of the body are carried forwards by the actions of thofe veffels in confequence of two kinds of ftimulus, one of which may be compared to a pleafurable fenfation or defire inducing the veffel to feize, and, as it were, to fwallow the particles thus felected from the

blood; as is done by the mouths of the various glands, veins, and other abſorbents, which may be called glandular appetency. The other kind of ſtimulus may be compared to diſagreeable ſenſation, or averſion, as when the heart has received the blood, and is ſtimulated by it to puſh it forwards into the arteries; the ſame again ſtimulates the arteries to contract, and carry forwards the blood to their extremities, the glands and capillaries. Thus the meſenteric veins abſorb the blood from the inteſtines by glandular appetency, and carry it forward to the vena portarum; which acting as an artery contracts itſelf by diſagreeable ſtimulus, and puſhes it to its ramified extremities, the various glands, which conſtitute the liver.

It ſeems probable, that at the beginning of the formation of theſe veſſels in the embryon, an agreeable ſenſation was in reality felt by the glands during ſecretion, as is now felt in the act of ſwallowing palatable food; and that a diſagreeable ſenſation was originally felt by the heart from the diſtention occaſioned by the blood, or by its chemical ſtimulus; but that by habit theſe are all become irritative motions; that is, ſuch motions as do not affect the whole ſyſtem, except when the veſſels are diſeaſed by inflammation.

SECT.

# SECT. XXIV.

## OF THE SECRETIONS OF SALIVA, AND OF TEARS, AND OF THE LACRYMAL SACK.

I. *Secretion of ſaliva increaſed by mercury in the blood.* 1. *By the food in the mouth. Dryneſs of the mouth not from a deficiency of ſaliva.* 2. *By ſenſitive ideas.* 3. *By volition.* 4. *By diſtaſteful ſubſtances. It is ſecreted in a dilute and ſaline ſtate. It then becomes more viſcid.* 5. *By ideas of diſtaſteful ſubſtances.* 6. *By nauſea.* 7. *By averſion.* 8. *By catenation with ſtimulating ſubſtances in the ear.* II. 1 *Secretion of tears leſs in ſleep. From ſtimulation of their excretory duct.* 2. *Lacrymal ſack is a gland.* 3. *Its uſes.* 4. *Tears are ſecreted, when the naſal duct is ſtimulated.* 5. *Or when it is excited by ſenſation.* 6. *Or by volition.* 7. *The lacrymal ſack can regurgitate its contents into the eye.* 8. *More tears are ſecreted by aſſociation with the irritation of the naſal duct of the lacrymal ſack, than the puncta lacrymalia can imbibe. Of the gout in the liver and ſtomach.*

I. The ſalival glands drink up a certain fluid from the circumfluent blood, and pour it into the mouth. They are ſometimes ſtimulated into action by the blood, that ſurrounds their origin, or by ſome part of that heterogeneous fluid: for when mercurial ſalts, or oxydes, are mixed with the blood, they ſtimulate theſe glands into unnatural

tural exertions; and then an unuſual quantity of ſaliva is ſeparated.

1. As the ſaliva ſecreted by theſe glands is moſt wanted during the maſtication of our food, it happens, when the terminations of their ducts in the mouth are ſtimulated into action, the ſalival glands themſelves are brought into increaſed action at the ſame time by aſſociation, and ſeparate a greater quantity of their juices from the blood; in the ſame manner as tears are produced in greater abundance during the ſtimulus of the vapour of onions, or of any other acrid material in the eye.

The ſaliva is thus naturally poured into the mouth only during the ſtimulus of our food in maſtication; for when there is too great an exhalation of the mucilaginous ſecretion from the membranes, which line the mouth, or too great an abſorption of it, the mouth becomes dry, though there is no deficiency in the quantity of ſaliva; as in thoſe who ſleep with their mouths open, and in ſome fevers.

2. Though during the maſtication of our natural food the ſalival glands are excited into action by the ſtimulus on their excretory ducts, and a due quantity of ſaliva is ſeparated from the blood, and poured into the mouth; yet as this maſtication of our food is always attended with a degree of pleaſure; and that pleaſurable ſenſation is alſo connected with our ideas of certain kinds

kinds of aliment; it follows, that when thefe ideas are reproduced, the pleafurable fenfation arifes along with them, and the falival glands are excited into action, and fill the mouth with faliva from this fenfitive affociation, as is frequently feen in dogs, who flaver at the fight of food.

3. We have alfo a voluntary power over the action of thefe falival glands, for we can at any time produce a flow of faliva into our mouth, and fpit out, or fwallow it at will.

4. If any very acrid material be held in the mouth, as the root of pyrethrum, or the leaves of tobacco, the falival glands are ftimulated into ftronger action than is natural, and thence fecrete a much larger quantity of faliva; which is at the fame time more vifcid than in its natural ftate; becaufe the lymphatics, that open their mouths into the ducts of the falival glands, and on the membranes, which line the mouth, are likewife ftimulated into ftronger action, and abforb the more liquid parts of the faliva with greater avidity; and the remainder is left both in greater quantity and more vifcid.

The increafed abforption in the mouth by fome ftimulating fubftances, which are called aftringents, as crab-juice, is evident from the inftant drynefs produced in the mouth by a fmall quantity of them.

As the extremities of the glands are of exquifite tenuity, as appears by their difficulty of injection, it

it was neceſſary for them to ſecrete their fluids in a very dilute ſtate; and, probably for the purpoſe of ſtimulating them into action, a quantity of neutral ſalt is likewiſe ſecreted or formed by the gland. This aqueous and ſaline part of all ſecreted fluids is again reabſorbed into the habit. More than half of ſome ſecreted fluids is thus imbibed from the reſervoirs, into which they are poured; as in the urinary bladder much more than half of what is ſecreted by the kidneys becomes reabſorbed by the lymphatics, which are thickly diſperſed around the neck of the bladder. This ſeems to be the purpoſe of the urinary bladders of fiſh, as otherwiſe ſuch a receptacle for the urine could have been of no uſe to an animal immerſed in water.

5. The idea of ſubſtances diſagreeably acrid will alſo produce a quantity of ſaliva in the mouth; as when we ſmell very putrid vapours, we are induced to ſpit out our ſaliva, as if ſomething diſagreeable was actually upon our palates.

6. When diſagreeable food in the ſtomach produces nauſea, a flow of ſaliva is excited in the mouth by aſſociation; as efforts to vomit are frequently produced by diſagreeable drugs in the mouth by the ſame kind of aſſociation.

7. A preternatural flow of ſaliva is likewiſe ſometimes occaſioned by a diſeaſe of the voluntary power; for if we think about our ſaliva, and determine not to ſwallow it, or not to ſpit it out,

an

an exertion is produced by the will, and more ſaliva is ſecreted againſt our wiſh; that is, by our averſion, which bears the ſame analogy to deſire, as pain does to pleaſure; as they are only modifications of the ſame diſpoſition of the ſenſorium. See Claſs IV. 3. 2. 1.

8. The quantity of ſaliva may alſo be increaſed beyond what is natural, by the catenation of the motions of theſe glands with other motions, or ſenſations, as by an extraneous body in the ear; of which I have known an inſtance; or by the application of ſtizolobium, ſiliqua hirſuta, cowhage, to the ſeat of the parotis, as ſome writers have affirmed.

II. 1. The lacrymal gland drinks up a certain fluid from the circumfluent blood, and pours it on the ball of the eye, on the upper part of the external corner of the eyelids. Though it may perhaps be ſtimulated into the performance of its natural action by the blood, which ſurrounds its origin, or by ſome part of that heterogeneous fluid; yet as the tears ſecreted by this gland are more wanted at ſome times than at others, its ſecretion is variable, like that of the ſaliva above mentioned, and is chiefly produced when its excretory duct is ſtimulated; for in our common ſleep there ſeems to be little or no ſecretion of tears; though they are occaſionally produced by our ſenſations in dreams.

Thus when any extraneous material on the eye-

ball, or the dryneſs of the external covering of it, or the coldneſs of the air, or the acrimony of ſome vapours, as of onions, ſtimulates the excretory duct of the lacrymal gland, it diſcharges its contents upon the ball; a quicker ſecretion takes place in the gland, and abundant tears ſucceed, to moiſten, clean, and lubricate the eye. Theſe by frequent nictitation are diffuſed over the whole ball, and as the external angle of the eye in winking is cloſed ſooner than the internal angle, the tears are gradually driven forwards, and downwards from the lacrymal gland to the puncta lacrymalia.

2. The lacrymal ſack, with its puncta lacrymalia, and its naſal duct, is a complete gland; and is ſingular in this reſpect, that it neither derives its fluid from, nor diſgorges it, into the circulation. The ſimplicity of the ſtructure of this gland, and both the extremities of it being on the ſurface of the body, makes it well worthy our minuter obſervation; as the actions of more intricate and concealed glands may be better underſtood from their analogy to this.

3. This ſimple gland conſiſts of two abſorbing mouths, a belly, and an excretory duct. As the tears are brought to the internal angle of the eye, theſe two mouths drink them up, being ſtimulated into action by this fluid, which they abſorb. The belly of the gland, or lacrymal ſack, is thus filled, in which the ſaline part of the

tears is abſorbed, and when the other end of the gland, or naſal duct, is ſtimulated by the dryneſs, or pained by the coldneſs of the air, or affected by any acrimonious duſt or vapour in the noſtrils, it is excited into action together with the ſack, and the tears are diſgorged upon the membrane, which lines the noſtrils; where they ſerve a ſecond purpoſe to moiſten, clean, and lubricate, the organ of ſmell.

4. This gland, when its naſal duct is ſtimulated by any very acrid material, as the powder of tobacco, or volatile ſpirits, not only diſgorges the contents of its belly or receptacle (the lacrymal ſack), and abſorbs haſtily all the fluid, that is ready for it in the corner of the eye; but by the aſſociation of its motions with thoſe of the lacrymal gland, excites that alſo into increaſed action, and a large flow of tears is poured into the eye.

5. This naſal duct is likewiſe excited into ſtrong action by ſenſitive ideas, as in grief, or joy, and then alſo by its aſſociations with the lacrymal gland it produces a great flow of tears without any external ſtimulus; as is more fully explained in Sect. XVI. 8. on Inſtinct.

6. There are ſome, famous in the arts of exciting compaſſion, who are ſaid to have acquired a voluntary power of producing a flow of tears in the eye; which, from what has been ſaid in the ſection on Inſtinct above mentioned, I ſhould ſuſpect,

ſuſpect, is performed by acquiring a voluntary power over the action of this naſal duct.

7. There is another circumſtance well worthy our attention, that when by any accident this naſal duct is obſtructed, the lacrymal ſack, which is the belly or receptacle of this gland, by ſlight preſſure of the finger is enabled to diſgorge its contents again into the eye; perhaps the bile in the ſame manner, when the biliary ducts are obſtructed, is returned into the blood by the veſſels which ſecrete it?

8. A very important though minute occurrence muſt here be obſerved, that though the lacrymal gland is only excited into action, when we weep at a diſtreſsful tale, by its aſſociation with this naſal duct, as is more fully explained in Sect. XVI. 8; yet the quantity of tears ſecreted at once is more than the puncta lacrymalia can readily abſorb; which ſhews *that the motions occaſioned by aſſociations are frequently more energetic than the original motions, by which they were occaſioned.* Which we ſhall have occaſion to mention hereafter, to illuſtrate, why pains frequently exiſt in a part diſtant from the cauſe of them, as in the other end of the urethra, when a ſtone ſtimulates the neck of the bladder. And why inflammations frequently ariſe in parts diſtant from their cauſe, as the gutta roſea of drinking people, from an inflamed liver.

The inflammation of a part is generally preceded

by a torpor or quiefcence of it; if this exifts in any larger congeries of glands, as in the liver, or any membranous part, as the ftomach, pain is produced and chillinefs in confequence of the torpor of the veffels. In this fituation fometimes an inflammation of the parts fucceeds the torpor; at other times a diftant more fenfible part becomes inflamed; whofe actions have previoufly been affociated with it: and the torpor of the firft part ceafes. This I apprehend happens, when the gout of the foot fucceeds a pain of the biliary duct, or of the ftomach. Laftly, it fometimes happens, that the pain of torpor exifts without any confequent inflammation of the affected part, or of any diftant part affociated with it, as in the membranes about the temple and eye-brows in hemicrania, and in thofe pains, which occafion convulfions; if this happens to gouty people, when it affects the liver, I fuppofe epileptic fits are produced; and, when it affects the ftomach, death is the confequence. In thefe cafes the pulfe is weak, and the extremities cold, and fuch medicines as ftimulate the quiefcent parts into action, or which induce inflammation in them, or in any diftant part, which is affociated with them, cures the prefent pain of torpor, and faves the patient.

I have twice feen a gouty inflammation of the liver, attended with jaundice; the patients after a few days were both of them affected with cold fits,

fits, like ague fits, and their feet became affected with gout, and the inflammation of their livers ceafed. It is probable, that the uneafy fenfations about the ftomach, and indigeftion, which precedes gouty paroxyfms, are generally owing to torpor or flight inflammation of the liver, and biliary ducts; but where great pain with continued ficknefs, with feeble pulfe, and fenfation of cold, affect the ftomach in patients debilitated by the gout, that it is a torpor of the ftomach itfelf, and deftroys the patient from the great connexion of that vifcus with the vital organs. See Sect. XXV. 17.

# SECT. XXV.

## OF THE STOMACH AND INTESTINES.

1. *Of ſwallowing our food. Ruminating animals.* 2. *Action of the ſtomach.* 3. *Action of the inteſtines. Irritative motions connected with theſe.* 4. *Effects of repletion.* 5. *Stronger action of the ſtomach and inteſtines from more ſtimulating food.* 6. *Their action inverted by ſtill greater ſtimuli. Or by diſguſtful ideas. Or by volition.* 7. *Other glands ſtrengthen or invert their motions by ſympathy.* 8. *Vomiting performed by intervals.* 9. *Inverſion of the cutaneous abſorbents.* 10. *Increaſed ſecretion of bile and pancreatic juice.* 11. *Inverſion of the lacteals.* 12. *And of the bile-ducts.* 13. *Caſe of a cholera.* 14. *Farther account of the inverſion of lacteals.* 15. *Iliac paſſion. Valve of the colon.* 16. *Cure of the iliac paſſion.* 17. *Pain of gall-ſtone diſtinguiſhed from pain of the ſtomach. Gout of the ſtomach from torpor, from inflammation. Intermitting pulſe owing to indigeſtion. To overdoſe of foxglove. Weak pulſe from emetics. Death from a blow on the ſtomach. From gout of the ſtomach.*

1. The throat, ſtomach, and inteſtines, may be conſidered as one great gland; which like the lacrymal ſack above mentioned, neither begins nor ends in the circulation. Though the act of maſticating our aliment belongs to the ſenſitive claſs of motions, for the pleaſure of its taſte induces

duces the muſcles of the jaw into action; yet the deglutition of it when maſticated is generally, if not always, an irritative motion, occaſioned by the application of the food already maſticated to the origin of the pharynx; in the ſame manner as we often ſwallow our ſpittle without attending to it.

The ruminating claſs of animals have the power to invert the motion of their gullet, and of their firſt ſtomach, from the ſtimulus of this aliment, when it is a little further prepared; as is their daily practice in chewing the cud; and appears to the eye of any one, who attends to them, whilſt they are employed in this ſecond maſtication of their food.

2. When our natural aliment arrives into the ſtomach, this organ is ſtimulated into its proper vermicular action; which beginning at the upper orifice of it, and terminating at the lower one, gradually mixes together and puſhes forwards the digeſting materials into the inteſtine beneath it.

At the ſame time the glands, that ſupply the gaſtric juices, which are neceſſary to promote the chemical part of the proceſs of digeſtion, are ſtimulated to diſcharge their contained fluids, and to ſeparate a further ſupply from the blood-veſſels: and the lacteals or lymphatics, which open their mouths into the ſtomach, are ſtimulated in-

to action, and take up ſome part of the digeſting materials.

3. The remainder of theſe digeſting materials is carried forwards into the upper inteſtines, and ſtimulates them into their periſtaltic motion ſimilar to that of the ſtomach; which continues gradually to mix the changing materials, and paſs them along through the valve of the colon to the excretory end of this great gland, the ſphincter ani.

The digeſting materials produce a flow of bile, and of pancreatic juice, as they paſs along the duodenum, by ſtimulating the excretory ducts of the liver and pancreas, which terminate in that inteſtine: and other branches of the abſorbent or lymphatic ſyſtem, called lacteals, are excited to drink up, as it paſſes, thoſe parts of the digeſting materials, that are proper for their purpoſe, by its ſtimulus on their mouths.

4. When the ſtomach and inteſtines are thus filled with their proper food, not only the motions of the gaſtric glands, the pancreas, liver, and lacteal veſſels, are excited into action; but at the ſame time the whole tribe of irritative motions are exerted with greater energy, a greater degree of warmth, colour, plumpneſs, and moiſture, is given to the ſkin from the increaſed action of thoſe glands called capillary veſſels; pleaſurable ſenſation is excited, the voluntary motions

tions are lefs eafily exerted, and at length fufpended; and fleep fucceeds, unlefs it be prevented by the ftimulus of furrounding objects, or by voluntary exertion, or by an acquired habit, which was originally produced by one or other of thefe circumftances, as is explained in Sect. XXI. on Drunkennefs.

At this time alfo, as the blood-veffels become replete with chyle, more urine is feparated into the bladder, and lefs of it is reabforbed; more mucus poured into the cellular membranes, and lefs of it reabforbed: the pulfe becomes fuller, and fofter, and in general quicker. The reafon why lefs urine and cellular mucus is abforbed after a full meal with fufficient drink is owing to the blood-veffels being fuller: hence one means to promote abforption is to decreafe the refiftance by emptying the veffels by venefection. From this decreafed abforption the urine becomes pale as well as copious, and the fkin appears plump as well as florid.

By daily repetition of thefe movements they all become connected together, and make a diurnal circle of irritative action, and if one of this chain be difturbed, the whole is liable to be put into diforder. See Sect. XX. on Vertigo.

5. When the ftomach and inteftines receive a quantity of food, whofe ftimulus is greater than ufual, all their motions, and thofe of the glands and lymphatics, are ftimulated into

ftronger

ſtronger action than uſual, and perform their offices with greater vigour and in leſs time: ſuch are the effects of certain quantities of ſpice or of vinous ſpirit.

6. But if the quantity or duration of theſe ſtimuli are ſtill further increaſed, the ſtomach and throat are ſtimulated into a motion, whoſe direction is contrary to the natural one above deſcribed; and they regurgitate the materials, which they contain, inſtead of carrying them forwards. This retrograde motion of the ſtomach may be compared to the ſtretchings of wearied limbs the contrary way, and is well elucidated by the following experiment. Look earneſtly for a minute or two on an area an inch ſquare of pink ſilk, placed in a ſtrong light, the eye becomes fatigued, the colour becomes faint, and at length vaniſhes, for the fatigued eye can no longer be ſtimulated into direct motions; then on cloſing the eye a green ſpectrum will appear in it, which is a colour directly contrary to pink, and which will appear and diſappear repeatedly, like the efforts in vomiting. See Section XXIX. 11.

Hence all thoſe drugs, which by their bitter or aſtringent ſtimulus increaſe the action of the ſtomach, as camomile and white vitriol, if their quantity is increaſed above a certain doſe become emetics.

Theſe inverted motions of the ſtomach and throat are generally produced from the ſtimulus

of

of unnatural food, and are attended with the fenfation of naufea or ficknefs: but as this fenfation is again connected with an idea of the diftafteful food, which induced it; fo an idea of naufeous food will alfo fometimes excite the action of naufea; and that give rife by affociation to the inverfion of the motions of the ftomach and throat. As fome, who have had horfe-flefh or dogs-flefh given them for beef or mutton, are faid to have vomited many hours afterwards, when they have been told of the impofition.

I have been told of a perfon, who had gained a voluntary command over thefe inverted motions of the ftomach and throat, and fupported himfelf by exhibiting this curiofity to the public. At thefe exhibitions he fwallowed a pint of red rough goofeberries, and a pint of white fmooth ones, brought them up in fmall parcels into his mouth, and reftored them feparately to the fpectators, who called for red or white as they pleafed, till the whole were redelivered.

7. At the fame time that thefe motions of the ftomach and throat are ftimulated into inverfion, fome of the other irritative motions, that had acquired more immediate connexions with the ftomach, as thofe of the gaftric glands, are excited into ftronger action by this affociation; and fome other of thefe motions, which are more eafily excited, as thofe of the gaftric lymphatics, are inverted by their affociation with the retrograde motions

 tions

tions of the ſtomach, and regurgitate their contents, and thus a greater quantity of mucus, and of lymph, or chyle, is poured into the ſtomach, and thrown up along with its contents.

8. Theſe inverſions of the motion of the ſtomach in vomiting are performed by intervals, for the ſame reaſon that many other motions are reciprocally exerted and relaxed; for during the time of exertion the ſtimulus, or ſenſation, which cauſed this exertion, is not perceived; but begins to be perceived again, as ſoon as the exertion ceaſes, and is ſome time in again producing its effect. As explained in Sect. XXXIV. on Volition, where it is ſhewn, that the contractions of the fibres, and the ſenſation of pain, which occaſioned that exertion, cannot exiſt at the ſame time. The exertion ceaſes from another cauſe alſo, which is the exhauſtion of the ſenſorial power of the part, and theſe two cauſes frequently operate together.

9. At the times of theſe inverted efforts of the ſtomach not only the lymphatics, which open their mouths into the ſtomach, but thoſe of the ſkin alſo, are for a time inverted: for ſweats are ſometimes puſhed out during the efforts of vomiting without an increaſe of heat.

10. But if by a greater ſtimulus the motions of the ſtomach are inverted ſtill more violently or more permanently, the duodenum has its periſtaltic motions inverted at the ſame time by their aſ-

ſociation

ſociation with thoſe of the ſtomach; and the bile and pancreatic juice, which it contains, are by the inverted motions brought up into the ſtomach, and diſcharged along with its contents; while a great quantity of bile and pancreatic juice is poured into this inteſtine; as the glands, that ſecrete them, are by their aſſociation with the motions of the inteſtine excited into ſtronger action than uſual.

11. The other inteſtines are by aſſociation excited into more powerful action, while the lymphatics, that open their mouths into them, ſuffer an inverſion of their motions correſponding with the lymphatics of the ſtomach, and duodenum; which with a part of the abundant ſecretion of bile is carried downwards, and contributes both to ſtimulate the bowels, and to increaſe the quantity of the evacuations. This inverſion of the motion of the lymphatics appears from the quantity of chyle, which comes away by ſtools; which is otherwiſe abſorbed as ſoon as produced, and by the immenſe quantity of thin fluid, which is evacuated along with it.

12. But if the ſtimulus, which inverts the ſtomach, be ſtill more powerful, or more permanent, it ſometimes happens, that the motions of the biliary glands, and of their excretory ducts, are at the ſame time inverted, and regurgitate their contained bile into the blood-veſſels, as appears by the yellow colour of the ſkin, and of the

urine;

urine; and it is probable the pancreatic ſecretion may ſuffer an inverſion at the ſame time, though we have yet no mark by which this can be aſcertained.

13. Mr. —— ate two putrid pigeons out of a cold pigeon-pye, and drank about a pint of beer and ale along with them, and immediately rode about five miles. He was then ſeized with vomiting, which was after a few periods ſucceeded by purging; theſe continued alternately for two hours; and the purging continued by intervals for ſix or eight hours longer. During this time he could not force himſelf to drink more than one pint in the whole; this great inability to drink was owing to the nauſea, or inverted motions of the ſtomach, which the voluntary exertion of ſwallowing could ſeldom and with difficulty overcome; yet he diſcharged in the whole at leaſt ſix quarts; whence came this quantity of liquid? Firſt, the contents of the ſtomach were emitted, then of the duodenum, gall-bladder, and pancreas, by vomiting. After this the contents of the lower bowels; then the chyle, that was in the lacteal veſſels, and in the receptacle of chyle, was regurgitated into the inteſtines by a retrograde motion of theſe veſſels. And afterwards the mucus depoſited in the cellular membrane, and on the ſurface of all the other membranes, ſeems to have been abſorbed; and with the fluid abſorbed from the air to have been carried

ried up their refpective lymphatic branches by the increafed energy of their natural motions, and down the vifceral lymphatics, or lacteals, by the inverfion of their motions.

14. It may be difficult to invent experiments to demonftrate the truth of this inverfion of fome branches of the abforbent fyftem, and increafed abforption of others; but the analogy of thefe veffels to the inteftinal canal, and the fymptoms of many difeafes, render this opinion more probable than many other received opinions of the animal œconomy.

In the above inftance, after the yellow excrement was voided, the fluid ceafed to have any fmell, and appeared like curdled milk, and then thinner fluid, and fome mucus, were evacuated; did not thefe feem to partake of the chyle, of the mucous fluid from all the cells of the body, and laftly, of the atmofpheric moifture? All thefe facts may be eafily obferved by any one, who takes a brifk purge.

15. Where the ftimulus on the ftomach, or on fome other part of the inteftinal canal, is ftill more permanent, not only the lacteal veffels, but the whole canal itfelf, becomes inverted from its affociations: this is the iliac paffion, in which all the fluids mentioned above are thrown up by the mouth. At this time the valve in the colon, from the inverted motions of that bowel, and the in-

verted

verted action of this living valve, does not prevent the regurgitation of its contents.

The ſtructure of this valve may be repreſented by a flexile leathern pipe ſtanding up from the bottom of a veſſel of water: its ſides collapſe by the preſſure of the ambient fluid, as a ſmall part of that fluid paſſes through it; but if it has a living power, and by its inverted action keeps itſelf open, it becomes like a rigid pipe, and will admit the whole liquid to paſs. See Sect. XXXIX. 2. 5.

In this caſe the patient is averſe to drink, from the conſtant inverſion of the motions of the ſtomach, and yet many quarts are daily ejected from the ſtomach, which at length ſmell of excrement, and at laſt ſeem to be only a thin mucilaginous or aqueous liquor.

From whence is it poſſible, that this great quantity of fluid for many ſucceſſive days can be ſupplied, after the cells of the body have given up their fluids, but from the atmoſphere? When the cutaneous branch of abſorbents acts with unnatural ſtrength, it is probable the inteſtinal branch has its motions inverted, and thus a fluid is ſupplied without entering the arterial ſyſtem. Could oiling or painting the ſkin give a check to this diſeaſe?

So when the ſtomach has its motions inverted, the lymphatics of the ſtomach, which are moſt

ſtrictly

ſtrictly aſſociated with it, invert their motions at the ſame time. But the more diſtant branches of lymphatics, which are leſs ſtrictly aſſociated with it, act with increaſed energy; as the cutaneous lymphatics in the cholera, or iliac paſſion, above deſcribed. And other irritative motions become decreaſed, as the pulſations of the arteries, from the extra-derivation or exhauſtion of the ſenſorial power.

Sometimes when ſtronger vomiting takes place the more diſtant branches of the lymphatic ſyſtem invert their motions with thoſe of the ſtomach, and looſe ſtools are produced, and cold ſweats.

So when the lacteals have their motions inverted, as during the operation of ſtrong purges, the urinary and cutaneous abſorbents have their motions increaſed to ſupply the want of fluid in the blood, as in great thirſt; but after a meal with ſufficient potation the urine is pale, that is, the urinary abſorbents act weakly, no ſupply of water being wanted for the blood. And when the inteſtinal abſorbents act too violently, as when too great quantities of fluid have been drunk, the urinary abſorbents invert their motions to carry off the ſuperfluity, which is a new circumſtance of aſſociation, and a temporary diabetes ſupervenes.

16. I have had the opportunity of ſeeing four patients in the iliac paſſion, where the ejected

material smelled and looked like excrement. Two of these were so exhausted at the time I saw them, that more blood could not be taken from them, and as their pain had ceased, and they continued to vomit up every thing which they drank, I suspected that a mortification of the bowel had already taken place, and as they were both women advanced in life, and a mortification is produced with less preceding pain in old and weak people, these both died. The other two, who were both young men, had still pain and strength sufficient for further venesection, and they neither of them had any appearance of hernia, both recovered by repeated bleeding, and a scruple of calomel given to one, and half a dram to the other, in very small pills: the usual means of clysters, and purges joined with opiates, had been in vain attempted. I have thought an ounce or two of crude mercury in less violent diseases of this kind has been of use, by contributing to restore its natural motion to some part of the intestinal canal, either by its weight or stimulus; and that hence the whole tube recovered its usual associations of progressive peristaltic motion. I have in three cases seen crude mercury given in small doses, as one or two ounces twice a day, have great effect in stopping pertinacious vomitings.

17. Besides the affections above described, the stomach is liable, like many other membranes of

the body, to torpor without confequent inflammation: as happens to the membranes about the head in fome cafes of hemicrania, or in general head-ach. This torpor of the ftomach is attended with indigeftion, and confequent flatulency, and with pain, which is ufually called the cramp of the ftomach, and is relievable by aromatics, effential oils, alcohol, or opium.

The intrufion of a gall-ftone into the common bile-duct from the gall-bladder is fometimes miftaken for a pain of the ftomach, as neither of them is attended with fever; but in the paffage of a gall-ftone, the pain is confined to a lefs fpace, which is exactly where the common bile-duct enters the duodenum, as explained in Section XXX. 3. Whereas in this gaftrodynia the pain is diffufed over the whole ftomach; and, like other difeafes from torpor, the pulfe is weaker, and the extremities colder, and the general debility greater, than in the paffage of a gall-ftone; for in the former the debility is the confequence of the pain, in the latter it is the caufe of it.

Though the firft fits of the gout, I believe, commence with a torpor of the liver; and the ball of the toe becomes inflamed inftead of the membranes of the liver in confequence of this torpor, as a coryza or catarrh frequently fucceeds a long expofure of the feet to cold, as in fnow, or on a moift brick-floor; yet in old or

exhaufted conftitutions, which have been long habituated to its attacks, it fometimes commences with a torpor of the ftomach, and is transferable to every membrane of the body. When the gout begins with torpor of the ftomach, a painful fenfation of cold occurs, which the patient compares to ice, with weak pulfe, cold extremities, and ficknefs; this in its flighter degree is relievable by fpice, wine, or opium; in its greater degree it is fucceeded by fudden death, which is owing to the fympathy of the ftomach with the heart, as explained below.

If the ftomach becomes inflamed in confequence of this gouty torpor of it, or in confequence of its fympathy with fome other part, the danger is lefs. A ficknefs and vomiting continues many days, or even weeks, the ftomach rejecting every thing ftimulant, even opium or alcohol, together with much vifcid mucus; till the inflammation at length ceafes, as happens when other membranes, as thofe of the joints, are the feat of gouty inflammation; as obferved in Sect. XXIV. 2. 8.

The fympathy, or affociation of motions, between thofe of the ftomach and thofe of the heart, is evinced in many difeafes. Firft, many people are occafionally affected with an intermiffion of their pulfe for a few days, which then ceafes again. In this cafe there is a ftop of the motion of the heart, and at the fame time a tendency

to

to eructation from the ftomach. As foon as the patient feels a tendency to the intermiffion of the motion of his heart, if he voluntarily brings up wind from his ftomach, the ftop of the heart does not occur. From hence I conclude that the ftop of digeftion is the primary difeafe; and that air is inftantly generated from the aliment, which begins to ferment, if the digeftive procefs is impeded for a moment, (fee Sect. XXIII. 4.); and that the ftop of the heart is in confequence of the affociation of the motions of thefe vifcera, as explained in Sect. XXXV. 1. 4.; but if the little air, which is inftantly generated during the temporary torpor of the ftomach, be evacuated, the digeftion recommences, and the temporary torpor of the heart does not follow. One patient, whom I lately faw, and who had been five or fix days much troubled with this intermiffion of a pulfation of his heart, and who had hemicrania with fome fever, was immediately relieved from them all by lofing ten ounces of blood, which had what is termed an inflammatory cruft on it.

Another inftance of this affociation between the motions of the ftomach and heart is evinced by the exhibition of an over dofe of foxglove, which induces an inceffant vomiting, which is attended with very flow, and fometimes intermitting pulfe.—Which continues in fpite of the exhibition of wine and opium for two or three days. To the fame affociation muft be afcribed the weak

 pulfe,

pulſe, which conſtantly attends the exhibition of emetics during their operation. And alſo the ſudden deaths, which have been occaſioned in boxing by a blow on the ſtomach; and laſtly, the ſudden death of thoſe, who have been long debilitated by the gout, from the torpor of the ſtomach. See Sect. XXV. 1. 4.

SECT.

# SECT. XXVI.

## OF THE CAPILLARY GLANDS AND MEMBRANES.

I. 1. *The capillary veſſels are glands.* 2. *Their excretory ducts. Experiments on the mucus of the inteſtines, abdomen, cellular membrane, and on the humours of the eye.* 3. *Scurf on the head, cough, catarrh, diarrhœa, gonorrhœa.* 4. *Rheumatiſm. Gout. Leproſy.* II. 1. *The moſt minute membranes are unorganized.* 2. *Larger membranes are compoſed of the ducts of the capillaries, and the mouths of the abſorbents.* 3. *Mucilaginous fluid is ſecreted on their ſurfaces.* III. *Three kinds of rheumatiſm.*

I. 1. THE capillary veſſels are like all the other glands except the abſorbent ſyſtem, inaſmuch as they receive blood from the arteries, ſeparate a fluid from it, and return the remainder by the veins.

2. This ſeries of glands is of the moſt extenſive uſe, as their excretory ducts open on the whole external ſkin forming its perſpirative pores, and on the internal ſurfaces of every cavity of the body. Their ſecretion on the ſkin is termed inſenſible perſpiration, which in health is in part reabſorbed by the mouths of the lymphatics, and in part evaporated in the air; the ſecretion on the

membranes, which line the larger cavities of the body, which have external openings, as the mouth and inteſtinal canal, is termed mucus, but is not however coagulable by heat; and the ſecretion on the membranes of thoſe cavities of the body, which have no external openings, is called lymph or water, as in the cavities of the cellular membrane, and of the abdomen; this lymph however is coagulable by the heat of boiling water. Some mucus nearly as viſcid as the white of egg, which was diſcharged by ſtool, did not coagulate, though I evaporated it to one fourth of the quantity, nor did the aqueous and vitreous humours of a ſheep's eye coagulate by the like experiment; but the ſeroſity from an anaſarcous leg, and that from the abdomen of a dropſical perſon, and the cryſtalline humour of a ſheep's eye, coagulated in the ſame heat.

3. When any of theſe capillary glands are ſtimulated into greater irritative actions, than is natural, they ſecrete a more copious material; and as the mouths of the abſorbent ſyſtem, which open in their vicinity, are at the ſame time ſtimulated into greater action, the thinner and more ſaline part of the ſecreted fluid is taken up again; and the remainder is not only more copious but alſo more viſcid than natural. This is more or leſs troubleſome or noxious according to the importance of the functions of the part affected: on the ſkin and bronchiæ, where this ſecretion ought

naturally

naturally to evaporate, it becomes ſo viſcid as to adhere to the membrane; on the tongue it forms a pellicle, which can with difficulty be ſcraped off; produces the ſcurf on the heads of many people; and the mucus, which is ſpit up by others in coughing. On the noſtrils and fauces, when the ſecretion of theſe capillary glands is increaſed, it is termed ſimple catarrh: when in the inteſtines, a mucous diarrhœa; and in the urethra, or vagina, it has the name of gonorrhœa, or fluor albus.

4. When theſe capillary glands become inflamed, a ſtill more viſcid or even cretaceous humour is produced upon the ſurfaces of the membranes, which is the cauſe or the effect of rheumatiſm, gout, leproſy, and of hard tumours of the legs, which are generally termed ſcorbutic; all which will be treated of hereafter.

II. 1. The whole ſurface of the body, with all its cavities and contents, are covered with membrane. It lines every veſſel, forms every cell, and binds together all the muſcular and perhaps the oſſeous fibres of the body; and is itſelf therefore probably a ſimpler ſubſtance than thoſe fibres. And as the containing veſſels of the body from the largeſt to the leaſt are thus lined and connected with membranes, it follows that theſe membranes themſelves conſiſt of unorganized materials.

For however ſmall we may conceive the diameters

meters of the minuteſt veſſels of the body, which eſcape our eyes and glaſſes, yet theſe veſſels muſt conſiſt of coats or ſides, which are made up of an unorganized material, and which are probably produced from a gluten, which hardens after its production, like the ſilk or web of caterpillars and ſpiders. Of this material conſiſt the membranes, which line the ſhells of eggs, and the ſhell itſelf, both which are unorganized, and are formed from mucus, which hardens after it is formed, either by the abſorption of its more fluid part, or by its uniting with ſome part of the atmoſphere. Such is alſo the production of the ſhells of ſnails, and of ſhell-fiſh, and I ſuppoſe of the enamel of the teeth.

2. But though the membranes, that compoſe the ſides of the moſt minute veſſels, are in truth unorganized materials, yet the larger membranes, which are perceptible to the eye, ſeem to be compoſed of an intertexture of the mouths of the abſorbent ſyſtem, and of the excretory ducts of the capillaries, with their concomitant arteries, veins, and nerves: and from this conſtruction it is evident, that theſe membranes muſt poſſeſs great irritability to peculiar ſtimuli, though they are incapable of any motions, that are viſible to the naked eye: and daily experience ſhews us, that in their inflamed ſtate they have the greateſt ſenſibility to pain, as in the pleuriſy and paronychia.

3. On all theſe membranes a mucilaginous or aqueous

aqueous fluid is ſecreted, which moiſtens and lubricates their ſurfaces, as was explained in Section XXIII. 2. Some have doubted, whether this mucus is ſeparated from the blood by an appropriated ſet of glands, or exudes through the membranes, or is an abraſion or deſtruction of the ſurface of the membrane itſelf, which is continually repaired on the other ſide of it, but the great analogy between the capillary veſſels, and the other glands, countenances the former opinion; and evinces, that theſe capillaries are the glands, that ſecrete it; to which we muſt add, that the blood in paſſing theſe capillary veſſels undergoes a change in its colour from florid to purple, and gives out a quantity of heat; from whence, as in other glands, we muſt conclude that ſomething is ſecreted from it.

III. The ſeat of rheumatiſm is in the membranes, or upon them; but there are three very diſtinct diſeaſes, which commonly are confounded under this name. Firſt, when a membrane becomes affected with torpor, or inactivity of the veſſels which compoſe it, pain and coldneſs ſucceed, as in the hemicrania, and other head-achs, which are generally termed nervous rheumatiſm; they exiſt whether the part be at reſt or in motion, and are generally attended with other marks of debility.

Another rheumatiſm is ſaid to exiſt, when inflammation and ſwelling, as well as pain, affect ſome

ſome of the membranes of the joints, as of the ancles, wriſts, knees, elbows, and ſometimes of the ribs. This is accompanied with fever, is analogous to pleuriſy and other inflammations, and is termed the acute rheumatiſm.

A third diſeaſe is called chronic rheumatiſm, which is diſtinguiſhed from that firſt mentioned, as in this the pain only affects the patient during the motion of the part, and from the ſecond kind of rheumatiſm above deſcribed, as it is not attended with quick pulſe or inflammation. It is generally believed to ſucceed the acute rheumatiſm of the ſame part, and that ſome coagulable lymph, or cretaceous, or calculous material, has been left on the membrane; which gives pain, when the muſcles move over it, as ſome extraneous body would do, which was too inſoluble to be abſorbed. Hence there is an analogy between this chronic rheumatiſm and the diſeaſes which produce gravel or gout-ſtones; and it may perhaps receive relief from the ſame remedies, ſuch as aerated ſal ſoda.

SECT.

# SECT. XXVII.

## OF HÆMORRHAGES.

*I. The veins are abſorbent veſſels. 1. Hæmorrhages from inflammation. Caſe of hæmorrhage from the kidney cured by cold bathing. Caſe of hæmorrhage from the noſe cured by cold immerſion. II. Hæmorrhage from venous paralyſis. Of Piles. Black ſtools. Petechiæ. Conſumption. Scurvy of the lungs. Blackneſs of the face and eyes in epileptic fits. Cure of hæmorrhages from venous inability.*

I. As the imbibing mouths of the abſorbent ſyſtem already deſcribed open on the ſurface, and into the larger cavities of the body, ſo there is another ſyſtem of abſorbent veſſels, which are not commonly eſteemed ſuch, I mean the veins, which take up the blood from the various glands and capillaries, after their proper fluids or ſecretions have been ſeparated from it.

The veins reſemble the other abſorbent veſſels; as the progreſſion of their contents is carried on in the ſame manner in both, they alike abſorb their appropriated fluids, and have valves to prevent its regurgitation by the accidents of mechanical violence. This appears firſt, becauſe there is no pulſation in the very beginnings of the veins,

veins, as is ſeen by microſcopes; which muſt happen, if the blood was carried into them by the actions of the arteries. For though the concurrence of various venous ſtreams of blood from different diſtances muſt prevent any pulſation in the larger branches, yet in the very beginnings of all theſe branches a pulſation muſt unavoidably exiſt, if the circulation in them was owing to the intermitted force of the arteries. Secondly, the venous abſorption of blood from the penis, and from the teats of female animals after their erection, is ſtill more ſimilar to the lymphatic abſorption, as it is previouſly poured into cells, where all arterial impulſe muſt ceaſe.

There is an experiment, which ſeems to evince this venous abſorption, which conſiſts in the external application of a ſtimulus to the lips, as of vinegar, by which they become inſtantly pale; that is, the bibulous mouths of the veins by this ſtimulus are excited to abſorb the blood faſter, than it can be ſupplied by the uſual arterial exertion. See Sect. XXIII. 5.

1. There are two kinds of hæmorrhages frequent in diſeaſes, one is where the glandular or capillary action is too powerfully exerted, and propels the blood forwards more haſtily, than the veins can abſorb it; and the other is, where the abſorbent power of the veins is diminiſhed, or a branch of them is become totally paralytic.

The former of theſe caſes is known by the heat of

of the part, and the general fever or inflammation that accompanies the hæmorrhage. A hæmorrhage from the nose or from the lungs is sometimes a crisis of inflammatory diseases, as of the hepatitis and gout, and generally ceases spontaneously, when the vessels are considerably emptied. Sometimes the hæmorrhage recurs by daily periods accompanying the hot fits of fever, and ceasing in the cold fits, or in the intermissions; this is to be cured by removing the febrile paroxysms, which will be treated of in their place. Otherwise it is cured by venesection, by the internal or external preparations of lead, or by the application of cold, with an abstemious diet, and diluting liquids, like other inflammations. Which by inducing a quiescence on those glandular parts, that are affected, prevents a greater quantity of blood from being protruded forwards, than the veins are capable of absorbing.

Mr. B—— had a hæmorrhage from his kidney, and parted with not less than a pint of blood a day (by conjecture) along with his urine for above a fortnight: venesections, mucilages, balsams, preparations of lead, the bark, alum, and dragon's blood, opiates, with a large blister on his loins, were separately tried, in large doses, to no purpose. He was then directed to bathe in a cold spring up to the middle of his body only, the upper part being covered, and the

hæmorrhage

hæmorrhage diminiſhed at the firſt, and ceaſed at the ſecond immerſion.

In this caſe the external capillaries were rendered quieſcent by the coldneſs of the water, and thence a leſs quantity of blood was circulated through them; and the internal capillaries, or other glands, became quieſcent from their irritative aſſociations with the external ones; and the hæmorrhage was ſtopped a ſufficient time for the ruptured veſſels to contract their apertures, or for the blood in thoſe apertures to coagulate.

Mrs. K——— had a continued hæmorrhage from her noſe for ſome days; the ruptured veſſel was not to be reached by plugs up the noſtrils, and the ſenſibility of her fauces was ſuch that nothing could be born behind the uvula. After repeated veneſection, and other common applications, ſhe was directed to immerſe her whole head into a pail of water, which was made colder by the addition of ſeveral handfuls of ſalt, and the hæmorrhage immediately ceaſed, and returned no more; but her pulſe continued hard, and ſhe was neceſſitated to loſe blood from the arm on the ſucceeding day.

Query, might not the cold bath inſtantly ſtop hæmorrhages from the lungs in inflammatory caſes?—for the ſhortneſs of breath of thoſe, who go ſuddenly into cold water, is not owing to the accumulation of blood in the lungs, but to the

quiescence of the pulmonary capillaries from association, as explained in Section XXXII. 3. 2.

II. The other kind of hæmorrhage is known from its being attended with a weak pulse, and other symptoms of general debility, and very frequently occurs in those, who have diseased livers, owing to intemperance in the use of fermented liquors. These constitutions are shewn to be liable to paralysis of the lymphatic absorbents, producing the various kinds of dropsies in Section XXIX. 5. Now if any branch of the venous system loses its power of absorption, the part swells, and at length bursts and discharges the blood, which the capillaries or other glands circulate through them.

It sometimes happens that the large external veins of the legs burst, and effuse their blood; but this occurs most frequently in the veins of the intestines, as the vena portarum is liable to suffer from a schirrus of the liver opposing the progression of the blood, which is absorbed from the intestines. Hence the piles are a symptom of hepatic obstruction, and hence the copious discharges downwards or upwards of a black material, which has been called melancholia, or black bile; but is no other than the blood, which is probably discharged from the veins of the intestines.

J. F. Meckel, in his Experimenta de Finibus Vasorum, published at Berlin, 1772, mentions his discovery

discovery of a communication of a lymphatic vessel with the gastric branch of the vena portarum. It is possible, that when the motion of the lymphatic becomes retrograde in some diseases, blood may obtain a passage into it, where it anastomoses with the vein, and thus be poured into the intestines. A discharge of blood with the urine sometimes attends diabetes, and may have its source in the same manner.

Mr. A———, who had been a hard drinker, and had the gutta rosacea on his face and breast, after a stroke of the palsy voided near a quart of a black viscid material by stool: on diluting it with water it did not become yellow, as it must have done if it had been inspissated bile, but continued black like the grounds of coffee.

But any other part of the venous system may become quiescent or totally paralytic as well as the veins of the intestines: all which occur more frequently in those who have diseased livers, than in any others. Hence troublesome bleedings of the nose, or from the lungs with a weak pulse; hence hæmorrhages from the kidneys, too great menstruation; and hence the oozing of blood from every part of the body, and the petechiæ in those fevers, which are termed putrid, and which is erroneously ascribed to the thinness of the blood: for the blood in inflammatory diseases is equally fluid before it coagulates in the cold air.

Is not that hereditary consumption, which

occurs

occurs chiefly in darkeyed people about the age of twenty, and commences with slight pulmonary hæmorrhages without fever, a disease of this kind?—These hæmorrhages frequently begin during sleep, when the irritability of the lungs is not sufficient in these patients to carry on the circulation without the assistance of volition; for in our waking hours, the motions of the lungs are in part voluntary, especially if any difficulty of breathing renders the efforts of volition necessary. See Class I. 2. 1. 3. and Class III. 2. 1. 12. Another species of pulmonary consumption which seems more certainly of scrofulous origin is described in the next Section, No. 2.

I have seen two cases of women, of about forty years of age, both of whom were seized with quick weak pulse, with difficult respiration, and who spit up by coughing much viscid mucus mixed with dark coloured blood. They had both large vibices on their limbs, and petechiæ; in one the feet were in danger of mortification, in the other the legs were œdematous. To relieve the difficult respiration, about six ounces of blood were taken from one of them, which to my surprise was sizy, like inflamed blood: they had both palpitations or unequal pulsations of the heart. They continued four or five weeks with pale and bloated countenances, and did not cease spitting phlegm mixed with black blood, and the pulse seldom slower than 130 or 135 in a minute. This

blood, from its dark colour, and from the many vibices and petechiæ, feems to have been venous blood; the quicknefs of the pulfe, and the irregularity of the motion of the heart, are to be afcribed to debility of that part of the fyftem; as the extravafation of blood originated from the defect of venous abforption. The approximation of thefe two cafes to fea-fcurvy is peculiar, and may allow them to be called fcorbutus pulmonalis. Had thefe been younger fubjects, and the paralyfis of the veins had only affected the lungs, it is probable the difeafe would have been a pulmonary confumption.

Laft week I faw a gentleman of Birmingham, who had for ten days laboured under great palpitation of his heart, which was fo diftinctly felt by the hand, as to difcountenance the idea of there being a fluid in the pericardium. He frequently fpit up mucus ftained with dark coloured blood, his pulfe very unequal and very weak, with cold hands and nofe. He could not lie down at all, and for about ten days paft could not fleep a minute together, but waked perpetually with great uneafinefs. Could thofe fymptoms be owing to very extenfive adhefions of the lungs? or is this a fcorbutus pulmonalis? After a few days he fuddenly got fo much better as to be able to fleep many hours at a time by the ufe of one grain of powder of foxglove twice a day, and a grain of opium at night. After a few days longer,

longer, the bark was exhibited, and the opium continued with ſome wine; and the palpitations of his heart became much relieved, and he recovered his uſual degree of health, but died ſuddenly ſome months afterwards.

In epileptic fits the patients frequently become black in the face, from the temporary paralyſis of the venous ſyſtem of this part. I have known two inſtances where the blackneſs has continued many days. M. P——, who had drank intemperately, was ſeized with the epilepſy when he was in his fortieth year; in one of theſe fits the white part of his eyes was left totally black with effuſed blood; which was attended with no pain or heat, and was in a few weeks gradually abſorbed, changing colour as is uſual with vibices from bruiſes.

The hæmorrhages produced from the inability of the veins to abſorb the refluent blood, are cured by opium, the preparations of ſteel, lead, the bark, vitriolic acid, and bliſters; but theſe have the effect with much more certainty, if a veneſection to a few ounces, and a moderate cathartic with four or ſix grains of calomel be premiſed, where the patient is not already too much debilitated; as one great means of promoting the abſorption of any fluid conſiſts in previouſly emptying the veſſels, which are to receive it.

## SECT. XXVIII.

### OF THE PARALYSIS OF THE ABSORBENT SYSTEM.

*I. Paralysis of the lacteals, atrophy. Distaste to animal food. II. Cause of dropsy. Cause of herpes. Scrofula. Mesenteric consumption. Pulmonary consumption. Why ulcers in the lungs are so difficult to heal.*

The term paralysis has generally been used to express the loss of voluntary motion, as in the hemiplegia, but may with equal propriety be applied to express the disobediency of the muscular fibres to the other kinds of stimulus; as to those of irritation or sensation.

I. There is a species of atrophy, which has not been well understood; when the absorbent vessels of the stomach and intestines have been long inured to the stimulus of too much spirituous liquor, they at length, either by the too sudden omission of fermented or spirituous potation, or from the gradual decay of nature, become in a certain degree paralytic; now it is observed in the larger muscles of the body, when one side is paralytic, the other is more frequently in motion, owing to the less expenditure of sensorial power in

in the paralytic limbs; so in this case the other part of the absorbent system acts with greater force, or with greater perseverance, in consequence of the paralysis of the lacteals; and the body becomes greatly emaciated in a small time.

I have seen several patients in this disease, of which the following are the circumstances. 1. They were men about fifty years of age, and had lived freely in respect to fermented liquors. 2. They lost their appetite to animal food. 3. They became suddenly emaciated to a great degree. 4. Their skins were dry and rough. 5. They coughed and expectorated with difficulty a viscid phlegm. 6. The membrane of the tongue was dry and red, and liable to become ulcerous.

The inability to digest animal food, and the consequent distaste to it, generally precede the dropsy, and other diseases, which originate from spirituous potation. I suppose when the stomach becomes inirritable, that there is at the same time a deficiency of gastric acid; hence milk seldom agrees with these patients, unless it be previously curdled, as they have not sufficient gastric acid to curdle it; and hence vegetable food, which is itself acescent, will agree with their stomachs longer than animal food, which requires more of the gastric acid for its digestion.

In this disease the skin is dry from the increased absorption of the cutaneous lymphatics, the

fat is abſorbed from the increaſed abſorption of the cellular lymphatics, the mucus of the lungs is too viſcid to be eaſily ſpit up by the increaſed abſorption of the thinner parts of it, the membrana ſneideriana becomes dry, covered with hardened mucus, and at length becomes inflamed and full of apthæ, and either theſe ſloughs, or pulmonary ulcers, terminate the ſcene.

II. The immediate cauſe of dropſy is the paralyſis of ſome other branches of the abſorbent ſyſtem, which are called lymphatics, and which open into the larger cavities of the body, or into the cells of the cellular membrane; whence thoſe cavities or cells become diſtended with the fluid, which is hourly ſecreted into them for the purpoſe of lubricating their ſurfaces. As is more fully explained in No. 5. of the next Section.

As thoſe lymphatic veſſels conſiſt generally of a long neck or mouth, which drinks up its appropriated fluid, and of a conglobate gland, in which this fluid undergoes ſome change, it happens, that ſometimes the mouth of the lymphatic, and ſometimes the belly or glandular part of it, becomes totally or partially paralytic. In the former caſe, where the mouths of the cutaneous lymphatics become torpid or quieſcent, the fluid ſecreted on the ſkin ceaſes to be abſorbed, and erodes the ſkin by its ſaline acrimony, and produces eruptions termed herpes, the diſcharge from which is as ſalt, as the tears, which are ſecreted too faſt to

be

be reabſorbed, as in grief, or when the puncta lacrymalia are obſtructed, and which running down the cheek redden and inflame the ſkin.

When the mouths of the lymphatics, which open on the mucous membrane of the noſtrils, become torpid, as on walking into the air in a froſty morning; the mucus, which continues to be ſecreted, has not its aqueous and ſaline part reabſorbed, which running over the upper lip inflames it, and has a ſalt taſte, if it falls on the tongue.

When the belly, or glandular part of one of theſe lymphatics, becomes torpid, the fluid abſorbed by its mouth ſtagnates, and forms a tumour in the gland. This diſeaſe is called the ſcrofula. If theſe glands ſuppurate externally, they gradually heal, as thoſe of the neck; if they ſuppurate without an opening on the external habit, as the meſenteric glands, a hectic fever enſues, which deſtroys the patient; if they ſuppurate in the lungs, a pulmonary conſumption enſues, which is believed thus to differ from that deſcribed in the preceding Section, in reſpect to its ſeat or proximate cauſe.

It is remarkable, that matter produced by ſuppuration will lie concealed in the body many weeks, or even months, without producing hectic fever; but as ſoon as the wound is opened, ſo as to admit air to the ſurface of the ulcer, a hectic fever ſupervenes, even in very few hours, which

I formerly

I formerly conceived to be owing to the azotic part of the atmoſphere rather than to the oxygene; becauſe thoſe medicines, which contain much oxygene, as the calces or oxydes of metals, externally applied, greatly contribute to heal ulcers; of theſe are the ſolutions of lead, and mercury, and copper in acids, or their precipitates; but have ſince believed it to be owing to the oxygene. See Claſs II. 1. 6. 7. in Vol. II. of this work.

Hence when wounds are to be healed by the firſt intention, as it is called, it is neceſſary carefully to exclude the air from them. Hence we have one cauſe, which prevents pulmonary ulcers from healing, which is their being perpetually expoſed to the air.

Another cauſe of the difficulty of healing pulmonary ulcers may ariſe from the inactivity of the veſſels of the air cells, which are covered with a membrane differing both from that of the mucous membranes of other cavities of the body, and from the external ſkin. For it is probable, that the air-cells alone of the lungs conſtitute the organ of reſpiration, and not the internal ſurfaces of the branching veſſels of the trachea, which lead to the air-cells. And from a vegetable analogy mentioned below they probably exhale or perſpire either nothing or much leſs than the ſurfaces of the pulmonary veſſels, which lead to them. Hence the mucus, which in common coughs or ſuperficial peripneumony is ſecreted on

the ſurface of the branching veſſels of the lungs, is forced up in coughing by the air behind it, which is haſtily excluded from the air-cells, and ſlowly inhaled into them. But if there was any mucus or matter formed in theſe air-cells, it is not eaſy to underſtand how it could be brought up by coughing, as no air could get admittance behind it; which may be one cauſe of the difficulty of healing pulmonary ulcers if they exiſt on the ſurface of the air-cells; but not ſo, if they exiſt in the veſſels leading to the air-cells, as after a wound with a ſword, or when a vomica has burſt after a peripneumony.

In the vegetable ſyſtem, I think, there can be no doubt, but that the upper ſurface of the leaves conſtitutes the organ of reſpiration, and M. Bonnet in his Uſage des Feuilles ſhows by a curious experiment, that the upper ſurfaces of leaves do not exhale half ſo much as their under ſurfaces. He placed the ſtalks of many leaves freſh collected into glaſs-tubes filled with water, of many of theſe the upper ſurfaces were ſmeared with oil, and the under ſurfaces of many others of them; and he uniformly found by the ſinking of the water in the tubes, that the upper ſurfaces exhaled leſs by half than the under ſurfaces.

Both the dark-eyed patients, which are affected with pulmonary ulcers from deficient venous abſorption, as deſcribed in Section XXVII. 2. and the light-eyed patients from deficient lym-

phatic

phatic abſorption, which we are now treating of, have generally large apertures of the iris; theſe large pupils of the eyes are a common mark of want of irritability; and it generally happens, that an increaſe of ſenſibility, that is, of motions in conſequence of ſenſation, attends theſe conſtitutions. See Sect. XXXI. 2. Whence inflammations may occur in theſe from ſtagnated fluids more frequently than in thoſe conſtitutions, which poſſeſs more irritability and leſs ſenſibility.

Great expectations in reſpect to the cure of conſumptions, as well as of many other diſeaſes, are produced by the very ingenious exertions of Dr. Beddoes; who has eſtabliſhed an apparatus for breathing various mixtures of airs or gaſſes, at the hot-wells near Briſtol, which well deſerves the attention of the public.

Dr. Beddoes very ingeniouſly concludes, from the florid colour of the blood of conſumptive patients, that it abounds in oxygene; and that the redneſs of their tongues, and lips, and the fine bluſh of their cheeks, ſhew the preſence of the ſame principle, like fleſh reddened by nitre. And adds, that the circumſtance of the conſumptions of pregnant women being ſtopped in their progreſs during pregnancy, at which time their blood may be ſuppoſed to be in part deprived of its oxygene, by oxygenating the blood of the fœtus, is a forcible argument in favour of this theory; which muſt ſoon be confirmed or

confuted

confuted by his experiments. See Eſſay on Scurvy, Conſumption, &c. by Dr. Beddoes. Murray. London. Alſo Letter to Dr. Darwin by the ſame. Murray. London.

SECT.

# SECT. XXIX.

## ON THE RETROGRADE MOTIONS OF THE ABSORBENT SYSTEM.

I. *Account of the abſorbent ſyſtem.* II. *The valves of the abſorbent veſſels may ſuffer their fluids to regurgitate in ſome diſeaſes.* III. *Communication from the alimentary canal to the bladder by means of the abſorbent veſſels.* IV. *The phænomena of diabetes explained.* V. 1. *The phænomena of dropſies explained.* 2. *Caſes of the uſe of foxglove.* VI. *Of cold ſweats.* VII. *Tranſlations of matter, of chyle, of milk, of urine, operation of purging drugs applied externally.* VIII. *Circumſtances by which the fluids, that are effuſed by the retrograde motions of the abſorbent veſſels, are diſtinguiſhed.* IX. *Retrograde motions of vegetable juices.* X. *Objections anſwered.* XI. *The cauſes, which induce the retrograde motions of animal veſſels, and the medicines by which the natural motions are reſtored.*

*N. B. The following Section is a tranſlation of a part of a Latin theſis written by the late Mr. Charles Darwin, which was printed with his prize-diſſertation on a criterion between matter and mucus in* 1780. *Sold by Cadell, London.*

### I. *Account of the Abſorbent Syſtem.*

1. THE abſorbent ſyſtem of veſſels in animal bodies conſiſts of ſeveral branches, differing in reſpect

respect to their situations, and to the fluids, which they absorb.

The intestinal absorbents open their mouths on the internal surfaces of the intestines; their office is to drink up the chyle and the other fluids from the alimentary canal; and they are termed lacteals, to distinguish them from the other absorbent vessels, which have been termed lymphatics.

Those, whose mouths are dispersed on the external skin, imbibe a great quantity of water from the atmosphere, and a part of the perspirable matter, which does not evaporate, and are termed cutaneous absorbents.

Those, which arise from the internal surface of the bronchia, and which imbibe moisture from the atmosphere, and a part of the bronchial mucus, are called pulmonary absorbents.

Those, which open their innumerable mouths into the cells of the whole cellular membrane; and whose use is to take up the fluid, which is poured into those cells, after it has done its office there; may be called cellular absorbents.

Those, which arise from the internal surfaces of the membranes, which line the larger cavities of the body, as the thorax, abdomen, scrotum, pericardium, take up the mucus poured into those cavities; and are distinguished by the names of their respective cavities.

Whilst those, which arise from the internal

furfaces of the urinary bladder, gall-bladder, falivary ducts, or other receptacles of fecreted fluids, may take their names from thofe fluids; the thinner parts of which it is their office to abforb: as urinary, bilious, or falivary abforbents.

2. Many of thefe abforbent veffels, both lacteals and lymphatics, like fome of the veins, are replete with valves: which feem defigned to affift the progrefs of their fluids, or at leaft to prevent their regurgitation; where they are fubjected to the intermitted preffure of the mufcular, or arterial actions in their neighbourhood.

Thefe valves do not however appear to be neceffary to all the abforbents, any more than to all the veins; fince they are not found to exift in the abforbent fyftem of fifh; according to the difcoveries of the ingenious, and much lamented Mr. Hewfon. Philof. Tranf. v. 59, Enquiries into the Lymph. Syft. p. 94.

3. Thefe abforbent veffels are alfo furnifhed with glands, which are called conglobate glands; whofe ufe is not at prefent fufficiently inveftigated; but it is probable that they refemble the conglomerate glands both in ftructure and in ufe, except that their abforbent mouths are for the conveniency of fituation placed at a greater diftance from the body of the gland. The conglomerate glands open their mouths immediately into the fanguiferous veffels, which bring the blood, from whence they abforb their refpective fluids,

fluids, quite up to the gland; but these conglobate glands collect their adapted fluids from very distant membranes, or cysts, by means of mouths furnished with long necks for this purpose; and which are called lacteals, or lymphatics.

4. The fluids, thus collected from various parts of the body, pass by means of the thoracic duct into the left subclavian near the jugular vein; except indeed that those collected from the right side of the head and neck, and from the right arm, are carried into the right subclavian vein: and sometimes even the lymphatics from the right side of the lungs are inserted into the right subclavian vein: whilst those of the left side of the head open but just into the summit of the thoracic duct.

5. In the absorbent system there are many anastomoses of the vessels, which seem of great consequence to the preservation of health. These anastomoses are discovered by dissection to be very frequent between the intestinal and urinary lymphatics, as mentioned by Mr. Hewson, (Phil. Transf. v. 58.)

6. Nor do all the intestinal absorbents seem to terminate in the thoracic duct, as appears from some curious experiments of D. Munro, who gave madder to some animals, having previously put a ligature on the thoracic duct, and found their bones and the serum of their blood coloured red.

## II. *The Valves of the Absorbent System may suffer their Fluids to regurgitate in some Diseases.*

1. The many valves, which occur in the progress of the lymphatic and lacteal vessels, would seem insuperable obstacles to the regurgitation of their contents. But as these valves are placed in vessels, which are indued with life, and are themselves indued with life also; and are very irritable into those natural motions, which absorb, or propel the fluids they contain; it is possible, in some diseases, where these valves or vessels are stimulated into unnatural exertions, or are become paralytic, that during the diastole of the part of the vessel to which the valve is attached, the valve may not so completely close, as to prevent the relapse of the lymph or chyle. This is rendered more probable, by the experiments of injecting mercury, or water, or suet, or by blowing air down these vessels: all which pass the valves very easily, contrary to the natural course of their fluids, when the vessels are thus a little forcibly dilated, as mentioned by Dr. Haller, Elem. Physiol. t. iii. s. 4.

"The valves of the thoracic duct are few, some assert they are not more than twelve, and that they do not very accurately perform their office, as they do not close the whole area of the duct,

and thence may permit chyle to repafs them downwards. In living animals, however, though not always, yet more frequently than in the dead, they prevent the chyle from returning.' The principal of thefe valves is that, which prefides over the infertion of the thoracic duct, into the fubclavian vein; many have believed this alfo to perform the office of a valve, both to admit the chyle into the vein, and to preclude the blood from entering the duct; but in my opinion it is fcarcely fufficient for this purpofe." Haller, Elem. Phyf. t. vii. p. 226.

2. The mouths of the lymphatics feem to admit water to pafs through them after death, the inverted way, eafier than the natural one; fince an inverted bladder readily lets out the water with which it is filled; whence it may be inferred, that there is no obftacle at the mouths of thefe veffels to prevent the regurgitation of their contained fluids.

I was induced to repeat this experiment, and having accurately tied the ureters and neck of a frefh ox's bladder, I made an opening at the fundus of it; and then, having turned it infide outwards, filled it half full with water, and was furprifed to fee it empty itfelf fo haftily. I thought the experiment more appofite to my purpofe by fufpending the bladder with its neck downwards, as the lymphatics are chiefly fpread upon this part

 of

of it, as ſhewn by Dr. Watſon, Philoſ. Tranſ. v. 59. p. 392.

3. In ſome diſeaſes, as in the diabetes, and ſcrofula, it is probable the valves themſelves are diſeaſed, and are thence incapable of preventing the return of the fluids they ſhould ſupport. Thus the valves of the aorta itſelf have frequently been found ſcirrhous, according to the diſſections of Monſ. Lieutaud, and have given riſe to an interrupted pulſe, and laborious palpitations, by ſuffering a return of part of the blood into the heart. Nor are any parts of the body ſo liable to ſcirrhoſity as the lymphatic glands and veſſels, inſomuch that their ſcirrhoſities have acquired a diſtinct name, and been termed ſcrofula.

4. There are valves in other parts of the body, analogous to thoſe of the abſorbent ſyſtem, and which are liable, when diſeaſed, to regurgitate their contents: thus the upper and lower orifices of the ſtomach are cloſed by valves, which, when too great quantities of warm water have been drunk with a deſign to promote vomiting, have ſometimes reſiſted the utmoſt efforts of the abdominal muſcles, and diaphragm: yet, at other times, the upper valve, or cardia, eaſily permits the evacuation of the contents of the ſtomach; whilſt the inferior valve, or pylorus, permits the bile, and other contents of the duodenum, to regurgitate into the ſtomach.

5. The valve of the colon is well adapted to

prevent

prevent the retrograde motion of the excrements; yet, as this valve is poffeffed of a living power, in the iliac paffion, either from fpafm, or other unnatural exertions, it keeps itfelf open, and either fuffers or promotes the retrograde movements of the contents of the inteftines below; as in ruminating animals the mouth of the firft ftomach feems to be fo conftructed, as to facilitate or affift the regurgitation of the food; the rings of the œfophagus afterwards contracting themfelves in inverted order. De Haen, by means of a fyringe, forced fo much water into the rectum inteftinum of a dog, that he vomited it in a full ftream from his mouth; and in the iliac paffion above mentioned, excrements and clyfter are often evacuated by the mouth. See Section XXV. 15.

6. The puncta lacrymalia, with the lacrymal fack and nafal duct, compofe a complete gland, and much refemble the inteftinal canal: the puncta lacrymalia are abforbent mouths, that take up the tears from the eye, when they have done their office there, and convey them into the noftrils; but when the nafal duct is obftructed, and the lacrymal fack diftended with its fluid, on preffure with the finger the mouths of this gland (puncta lacrymalia) will readily difgorge the fluid, they had previoufly abforbed, back into the eye.

7. As the capillary veffels receive blood from the arteries, and feparating the mucus, or per-

ſpirable matter from it, convey the remainder back by the veins; theſe capillary veſſels are a ſet of glands, in every reſpect ſimilar to the ſecretory veſſels of the liver, or other large congeries of glands. The beginnings of theſe capillary veſſels have frequent anaſtomoſes into each other, in which circumſtance they are reſembled by the lacteals; and like the mouths or beginnings of other glands, they are a ſet of abſorbent veſſels, which drink up the blood which is brought to them by the arteries, as the chyle is drunk up by the lacteals: for the circulation of the blood through the capillaries is proved to be independent of arterial impulſe; ſince in the bluſh of ſhame, and in partial inflammations, their action is increaſed, without any increaſe of the motion of the heart.

8. Yet not only the mouths, or beginnings of theſe anaſtomoſing capillaries are frequently ſeen by microſcopes, to regurgitate ſome particles of blood, during the ſtruggles of the animal; but retrograde motion of the blood, in the veins of thoſe animals, from the very heart to the extremity of the limbs, is obſervable, by intervals, during the diſtreſſes of the dying creature. Haller, Elem. Phyſiol. t. i. p. 216. Now, as the veins have perhaps all of them a valve ſomewhere between their extremities and the heart, here is ocular demonſtration of the fluids in this diſeaſed condition of the animal, repaſſing

through

through venous valves: and it is hence highly probable, from the ſtricteſt analogy, that if the courſe of the fluids, in the lymphatic veſſels, could be ſubjected to microſcopic obſervation, they would alſo, in the diſeaſed ſtate of the animal, be ſeen to repaſs the valves, and the mouths of thoſe veſſels, which had previouſly abſorbed them, or promoted their progreſſion.

Mr. Cooper relates ſome curious inſtances of diſeaſed valves of the abſorbent ſyſtem, and found on diſſecting dogs, who had died ſome hours after he had put a ligature on the receptaculum chyli, that in the cellular membrane of thoſe dogs, which had their ſtomachs full previous to the application of the ligature, much chyle was effuſed on many of the viſcera, and into the cellular membrane connecting the laminæ of the meſentery, and on the anterior ſurfaces of the pancreas, and of the kidneys; part of which might have eſcaped from a rupture of the receptaculum chyli; yet other parts of this general effuſion of chyle muſt ſeem to have been occaſioned by their retrograde action in the dying ſtate of the animals. Medical Reſearches, p. 106.

There is a curious caſe of iſchuria related by Dr. J. Senter in the Tranſactions of the College of Philadelphia, Vol. I. 1793, which continued more than three years, during which time, if the urine was not drawn off by a catheter, it was frequently voided by vomiting, and ſometimes by the

 ſkin;

ſkin; which could not be accounted for, as Dr. Senter juſtly obſerves, but by ſuppoſing the exiſtence of the retrograde action of ſome parts of the lymphatic ſyſtem.

III. *Communication from the Alimentary Canal to the Bladder, by means of the Abſorbent Veſſels.*

Many medical philoſophers, both ancient and modern, have ſuſpected that there was a nearer communication between the ſtomach and the urinary bladder, than that of the circulation: they were led into this opinion from the great expedition with which cold water, when drunk to exceſs, paſſes off by the bladder; and from the ſimilarity of the urine, when produced in this haſty manner, with the material that was drunk.

The former of theſe circumſtances happens perpetually to thoſe who drink abundance of cold water, when they are much heated by exerciſe, and to many at the beginning of intoxication.

Of the latter, many inſtances are recorded by Etmuller, t. xi. p. 716. where ſimple water, wine, and wine with ſugar, and emulſions, were returned by urine unchanged.

There are other experiments, that ſeem to demonſtrate the exiſtence of another paſſage to the bladder, beſides that through the kidneys. Thus Dr.

Dr. Kratzenſtein put ligatures on the ureters of a dog, and then emptied the bladder by a catheter; yet in a little time the dog drank greedily, and made a quantity of water, (Diſputat. Morbor. Halleri. t. iv. p. 63.) A ſimilar experiment is related in the Philoſophical Tranſactions, with the ſame event, (No. 65, 67, for the year 1670.)

Add to this, that in ſome morbid caſes the urine has continued to paſs, after the ſuppuration or total deſtruction of the kidneys; of which many inſtances are referred to in the Elem. Phyſiol. t. vii. p. 379. of Dr. Haller.

From all which it muſt be concluded, that ſome fluids have paſſed from the ſtomach or abdomen, without having gone through the ſanguiferous circulation: and as the bladder is ſupplied with many lymphatics, as deſcribed by Dr. Watſon, in the Philoſ. Tranſ. v. 59. p. 392. and as no other veſſels open into it beſides theſe and the ureters, it ſeems evident, that the unnatural urine, produced as above deſcribed, when the ureters were tied, or the kidneys obliterated, was carried into the bladder by the retrograde motions of the urinary branch of the lymphatic ſyſtem.

The more certainly to aſcertain the exiſtence of another communication between the ſtomach and bladder, beſides that of the circulation, the following experiment was made, to which I muſt beg your patient attention:—A friend of mine (June 14, 1772) on drinking repeatedly of cold ſmall

ſmall punch, till he began to be intoxicated, made a quantity of colourleſs urine. He then drank about two drams of nitre diſſolved in ſome of the punch, and ate about twenty ſtalks of boiled aſparagus: on continuing to drink more of the punch, the next urine that he made was quite clear, and without ſmell; but in a little time another quantity was made, which was not quite ſo colourleſs, and had a ſtrong ſmell of the aſparagus: he then loſt about four ounces of blood from the arm.

The ſmell of aſparagus was not at all perceptible in the blood, neither when freſh taken, nor the next morning, as myſelf and two others accurately attended to; yet this ſmell was ſtrongly perceived in the urine, which was made juſt before the blood was taken from his arm.

Some bibulous paper, moiſtened in the ſerum of this blood, and ſuffered to dry, ſhewed no ſigns of nitre by its manner of burning. But ſome of the ſame paper, moiſtened in the urine, and dried, on being ignited, evidently ſhewed the preſence of nitre. This blood and the urine ſtood ſome days expoſed to the ſun in the open air, till they were evaporated to about a fourth of their original quantity, and began to ſtink: the paper, which was then moiſtened with the concentrated urine, ſhewed the preſence of much nitre by its manner of burning; whilſt that moiſtened with the blood ſhewed no ſuch appearance at all.

Hence

Hence it appears, that certain fluids at the beginning of intoxication, find another paſſage to the bladder beſides the long courſe of the arterial circulation; and as the inteſtinal abſorbents are joined with the urinary lymphatics by frequent anaſtomoſes, as Hewſon has demonſtrated; and as there is no other road, we may juſtly conclude, that theſe fluids paſs into the bladder by the urinary branch of the lymphatics, which has its motions inverted during the diſeaſed ſtate of the animal.

A gentleman, who had been ſome weeks affected with jaundice, and whoſe urine was in conſequence of a very deep yellow, took ſome cold ſmall punch, in which was diſſolved about a dram of nitre; he then took repeated draughts of the punch, and kept himſelf in a cool room, till on the approach of ſlight intoxication he made a large quantity of water; this water had a ſlight yellow tinge, as might be expected from a ſmall admixture of bile ſecreted from the kidneys; but if the whole of it had paſſed through the ſanguiferous veſſels, which were now replete with bile (his whole ſkin being as yellow as gold) would not this urine alſo, as well as that he had made for weeks before, have been of a deep yellow? Paper dipped in this water, and dryed, and ignited, ſhewed evident marks of the preſence of nitre, when the flame was blown out.

IV. *The*

IV. *The Phænomena of the Diabetes explained, and of ſome Diarrhœas.*

THE phænomena of many diſeaſes are only explicable from the retrograde motions of ſome of the branches of the lymphatic ſyſtem; as the great and immediate flow of pale urine in the beginning of drunkenneſs; in hyſteric paroxyſms; from being expoſed to cold air; or to the influence of fear or anxiety.

Before we endeavour to illuſtrate this doctrine, by deſcribing the phænomena of theſe diſeaſes, we muſt premiſe one circumſtance; that all the branches of the lymphatic ſyſtem have a certain ſympathy with each other, inſomuch that when one branch is ſtimulated into unuſual kinds or quantities of motion, ſome other branch has its motions either increaſed, or decreaſed, or inverted at the ſame time. This kind of ſympathy can only be proved by the concurrent teſtimony of numerous facts, which will be related in the courſe of the work. I ſhall only add here, that it is probable, that this ſympathy does not depend on any communication of nervous filaments, but on habit; owing to the various branches of this ſyſtem having frequently been ſtimulated into action at the ſame time.

There are a thouſand inſtances of involuntary motions

motions aſſociated in this manner; as in the act of vomiting, while the motions of the ſtomach and œſophagus are inverted, the pulſations of the arterial ſyſtem by a certain ſympathy become weaker; and when the bowels or kidneys are ſtimulated by poiſon, a ſtone, or inflammation, into more violent action; the ſtomach and œſophagus by ſympathy invert their motions.

1. When any one drinks a moderate quantity of vinous ſpirit, the whole ſyſtem acts with more energy by conſent with the ſtomach and inteſtines, as is ſeen from the glow on the ſkin, and the increaſe of ſtrength and activity; but when a greater quantity of this inebriating material is drunk, at the ſame time that the lacteals are excited into greater action to abſorb it; it frequently happens, that the urinary branch of abſorbents, which is connected with the lacteals by many anaſtomoſes, inverts its motions, and a great quantity of pale unanimalized urine is diſcharged. By this wiſe contrivance too much of an unneceſſary fluid is prevented from entering the circulation—This may be called the drunken diabetes, to diſtinguiſh it from the other temporary diabetes, which occur in hyſteric diſeaſes, and from continued fear or anxiety.

2. If this idle ingurgitation of too much vinous ſpirit be daily practiſed, the urinary branch of abſorbents at length gains a habit of invert-

ing

ing its motions, whenever the lacteals are much ſtimulated; and the whole or a great part of the chyle is thus daily carried to the bladder without entering the circulation, and the body becomes emaciated. This is one kind of chronic diabetes, and may be diſtinguiſhed from the others by the taſte and appearance of the urine; which is ſweet, and of the colour of whey, and may be termed the chyliferous diabetes.

3. Many children have a ſimilar depoſition of chyle in their urine, from the irritation of worms in their inteſtines, which ſtimulating the mouths of the lacteals into unnatural action, the urinary branch of the abſorbents becomes inverted, and carries part of the chyle to the bladder: part of the chyle alſo has been carried to the iliac and lumbar glands, of which inſtances are recorded by Haller, t. vii. 225. and which can be explained on no other theory: but the diſſections of the lymphatic ſyſtem of the human body, which have yet been publiſhed, are not ſufficiently extenſive for our purpoſe; yet if we may reaſon from comparative anatomy, this tranſlation of chyle to the bladder is much illuſtrated by the account given of this ſyſtem of veſſels in a turtle, by Mr. Hewſon, who obſerved, "That the lacteals near the root of the meſentery anaſtomoſe, ſo as to form a net-work, from which ſeveral large branches go into ſome conſiderable lymphatics lying near the ſpine;

ſpine; and which can be traced almoſt to the anus, and particularly to the kidneys. Philoſ. Tranſ. v. 59. p. 199—Enquiries, p. 74.

4. At the ſame time that the urinary branch of abſorbents, in the beginning of diabetes, is excited into inverted action, the cellular branch is excited by the ſympathy above mentioned, into more energetic action; and the fat, that was before depoſited, is reabſorbed and thrown into the blood veſſels; where it floats, and was miſtaken for chyle, till the late experiments of the ingenious Mr. Hewſon demonſtrated it to be fat.

This appearance of what was miſtaken for chyle in the blood, which was drawn from theſe patients, and the obſtructed liver, which very frequently accompanies this diſeaſe, ſeems to have led Dr. Mead to ſuſpect the diabetes was owing to a defect of ſanguification; and that the ſcirrhoſity of the liver was the original cauſe of it: but as the ſcirrhus of the liver is moſt frequently owing to the ſame cauſes, that produce the diabetes and dropſies; namely, the great uſe of fermented liquors; there is no wonder they ſhould exiſt together, without being the conſequence of each other.

5. If the cutaneous branch of abſorbents gains a habit of being excited into ſtronger action, and imbibes greater quantities of moiſture from the atmoſphere, at the ſame time that the urinary branch has its motions inverted, another kind of

diabetes is formed, which may be termed the aqueous diabetes. In this diabetes the cutaneous abforbents frequently imbibe an amazing quantity of atmofpheric moifture; infomuch that there are authentic hiftories, where many gallons a day, for many weeks together, above the quantity that has been drunk, have been difcharged by urine.

Dr. Keil, in his Medicina Statica, found that he gained eighteen ounces from the moift air of one night; and Dr. Percival affirms, that one of his hands imbibed, after being well chafed, near an ounce and half of water, in a quarter of an hour. (Tranfact. of the College, London, vol. ii. p. 102.) Home's Medic. Facts, p. 2. fect. 3.

Dr. Rollo in his work on Diabetes has fhewn, that one patient, whom he weighed after being ten minutes in the warm bath, did not weigh heavier on his leaving it. Dr. Currie, I think, mentions a fimilar fact. I fufpect, that if the bath be made very hot, perhaps much above animal heat, the bather may perfpire more than he abforbs, and become in reality lighter. And that in a more moderate heat, if the patient has been previoufly exhaufted by abftinence or fatigue, that he will abforb much; but that if his fyftem be already full of fluids, from the food and fluids, which he has previoufly eaten and drunk, he may not abforb any thing. See Clafs I. 3. 2. 6.

The pale urine in hyſterical women, or which is produced by fear or anxiety, is a temporary complaint of this kind; and it would in reality be the ſame diſeaſe, if it was confirmed by habit.

6. The purging ſtools, and pale urine, occaſioned by expoſing the naked body to cold air, or ſprinkling it with cold water, originate from a ſimilar cauſe; for the mouths of the cutaneous lymphatics being ſuddenly expoſed to cold become torpid, and ceaſe, or nearly ceaſe, to act; whilſt, by the ſympathy above deſcribed, not only the lymphatics of the bladder and inteſtines ceaſe alſo to abſorb the more aqueous and ſaline part of the fluids ſecreted into them; but it is probable that theſe lymphatics invert their motions, and return the fluids, which were previouſly abſorbed, into the inteſtines and bladder. At the very inſtant that the body is expoſed naked to the cold air, an unuſual movement is felt in the bowels; as is experienced by boys going into the cold bath: this could not occur from an obſtruction of the perſpirable matter, ſince there is not time for that to be returned to the bowels by the courſe of the circulation.

There is alſo a chronic aqueous diarrhœa, in which the atmoſpheric moiſture, drunk up by the cutaneous and pulmonary lymphatics, is poured into the inteſtines, by the retrograde motions of the lacteals. This diſeaſe is moſt ſimilar to the aqueous diabetes, and is frequently exchanged

for it: a diſtinct inſtance of this is recorded by Benningerus, Cent. v. Obſ. 98. in which an aqueous diarrhœa ſucceeded an aqueous diabetes, and deſtroyed the patient. There is a curious example of this, deſcribed by Sympſon (De Re Medica)—"A young man (ſays he) was ſeized with a fever, upon which a diarrhœa came on, with great ſtupor; and he refuſed to drink any thing, though he was parched up with exceſſive heat: the better to ſupply him with moiſture, I directed his feet to be immerſed in cold water; immediately I obſerved a wonderful decreaſe of water in the veſſel, and then an impetuous ſtream of a fluid, ſcarcely coloured, was diſcharged by ſtool, like a cataract."

7. There is another kind of diarrhœa, which has been called cœliaca; in this diſeaſe the chyle, drunk up by the lacteals of the ſmall inteſtines, is probably poured into the large inteſtines, by the retrograde motions of their lacteals: as in the chyliferous diabetes, the chyle is poured into the bladder, by the retrograde motions of the urinary branch of abſorbents.

The chyliferous diabetes, like this chyliferous diarrhœa, produces ſudden atrophy; ſince the nouriſhment, which ought to ſupply the hourly waſte of the body, is expelled by the bladder, or rectum: whilſt the aqueous diabetes, and the aqueous diarrhœa produce exceſſive thirſt; becauſe the moiſture, which is obtained from the

atmoſphere,

atmofphere, is not conveyed to the thoracic receptacle, as it ought to be, but to the bladder, or lower inteftines; whence the chyle, blood, and whole fyftem of glands, are robbed of their proportion of humidity.

8. There is a third fpecies of diabetes, in which the urine is mucilaginous, and appears ropy in pouring it from one veffel into another; and will fometimes coagulate over the fire. This difeafe appears by intervals, and ceafes again, and feems to be occafioned by a previous dropfy in fome part of the body. When fuch a collection is reabforbed, it is not always returned into the circulation; but the fame irritation that ftimulates one lymphatic branch to reabforb the depofited fluid, inverts the urinary branch, and pours it into the bladder. Hence this mucilaginous diabetes is a cure, or the confequence of a cure, of a worfe difeafe, rather than a difeafe itfelf.

Dr. Cotunnius gave half an ounce of cream of tartar, every morning, to a patient, who had the anafarca; and he voided a great quantity of urine; a part of which, put over the fire, coagulated, on the evaporation of half of it, fo as to look like the white of an egg. De Ifchiade Nervos.

This kind of diabetes frequently precedes a dropfy; and has this remarkable circumftance attending it, that it generally happens in the night; as during the recumbent ftate of the body, the

 fluid,

fluid, that was accumulated in the cellular membrane, or in the lungs, is more readily abſorbed, as it is leſs impeded by its gravity. I have ſeen more than one inſtance of this diſeaſe. Mr. D. a man in the decline of life, who had long accuſtomed himſelf to ſpirituous liquor, had ſwelled legs, and other ſymptoms of approaching anaſarca: about once in a week or ten days, (for ſeveral months, he was ſeized, on going to bed, with great general uneaſineſs, which his attendants reſembled to an hyſteric fit; and which terminated in a great diſcharge of viſcid urine; his legs became leſs ſwelled, and he continued in better health for ſome days afterwards. I had not the opportunity to try if this urine would coagulate over the fire, when part of it was evaporated, which I imagine would be the criterion of this kind of diabetes; as the mucilaginous fluid depoſited in the cells and cyſts of the body, which have no communication with the external air, ſeems to acquire, by ſtagnation, this property of coagulation by heat, which the ſecreted mucus of the inteſtines and bladder do not appear to poſſeſs; as I have found by experiment: and if any one ſhould ſuppoſe this coagulable urine was ſeparated from the blood by the kidneys, he may recollect, that in the moſt inflammatory diſeaſes, in which the blood is moſt replete or moſt ready to part with the coagulable lymph, none of this appears in the urine.

9. Different kinds of diabetes require different methods of cure. For the firſt kind, or chyliferous diabetes, after clearing the ſtomach and inteſtines, by ipecacuanha and rhubarb, to evacuate any acid material, which may too powerfully ſtimulate the mouths of the lacteals, repeated and large doſes of tincture of cantharides have been much recommended. The ſpecific ſtimulus of this medicine, on the neck of the bladder, is likely to excite the numerous abſorbent veſſels, which are ſpread on that part, into ſtronger natural actions, and by that means prevent their retrograde ones; till, by perſiſting in the uſe of the medicine, their natural habits of motions might again be eſtabliſhed. Another indication of cure, requires ſuch medicines, as by lining the inteſtines with mucilaginous ſubſtances, or with ſuch as conſiſt of ſmooth particles, or which chemically deſtroy the acrimony of their contents, may prevent the too great action of the inteſtinal abſorbents. For this purpoſe, I have found the earth precipitated from a ſolution of alum, by means of fixed alcali, given in the doſe of half a dram every ſix hours, of great advantage, with a few grains of rhubarb, ſo as to produce a daily evacuation.

The food ſhould conſiſt of materials that have the leaſt ſtimulus, with calcareous water, as of Briſtol and Matlock; that the mouths of the lacteals may be as little ſtimulated as is neceſſary for

their proper abſorption; leſt with their greater exertions, ſhould be connected by ſympathy, the inverted motions of the urinary lymphatics.

The ſame method may be employed with equal advantage in the aqueous diabetes, ſo great is the ſympathy between the ſkin and the ſtomach. To which, however, ſome application to the ſkin might be uſefully added; as rubbing the patient all over with oil, to prevent the too great action of the cutaneous abſorbents. I knew an experiment of this kind made upon one patient with apparent advantage.

The mucilaginous diabetes will require the ſame treatment, which is moſt efficacious in the dropſy, and will be deſcribed below. I muſt add, that the diet and medicines above mentioned, are ſtrongly recommended by various authors, as by Morgan, Willis, Harris, and Etmuller; but more hiſtories of the ſucceſsful treatment of theſe diſeaſes are wanting to fully aſcertain the moſt efficacious methods of cure.

In a letter from Mr. Charles Darwin, dated April 24, 1778, Edinburgh, is the ſubſequent paſſage:—" A man who had long laboured under a diabetes died yeſterday in the clinical ward. He had for ſome time drunk four, and paſſed twelve pounds of fluid daily: each pound of urine contained an ounce of ſugar. He took, without conſiderable relief, gum kino, ſanguis draconis melted with alum, tincture of cantharides,

rides, iſinglaſs, gum arabic, crabs eyes, ſpirit of hartſhorn, and eat ten or fifteen oyſters thrice a day. Dr. Home, having read my theſis, bled him, and found that neither the freſh blood nor the ſerum taſted ſweet. His body was opened this morning—every viſcus appeared in a ſound and natural ſtate, except that the left kidney had a very ſmall pelvis, and that there was a conſiderable enlargement of moſt of the meſenteric lymphatic glands. I intend to inſert this in my theſis, as it coincides with the experiment, where ſome aſparagus was eaten at the beginning of intoxication, and its ſmell perceived in the urine, though not in the blood."

The following caſe of chyliferous diabetes is extracted from ſome letters of Mr. Hughes, to whoſe unremitted care the infirmary at Stafford for many years was much indebted. Dated October 10, 1778.

Richard Davis, aged 33, a whiteſmith by trade, had drunk hard by intervals; was much troubled with ſweating of his hands, which incommoded him in his occupation, but which ceaſed on his frequently dipping them in lime. About ſeven months ago he began to make large quantities of water; his legs are œdematous, his belly tenſe, and he complains of a riſing in his throat, like the globus hyſtericus: he eats twice as much as other people, drinks about fourteen pints of ſmall beer a day, beſides a pint of ale,

ſome milk-porridge, and a baſon of broth, and he makes about eighteen pints of water a day.

He tried alum, dragon's blood, ſteel, blue vitriol, and cantharides in large quantities, and duly repeated, under the care of Dr. Underhill, but without any effect; except that on the day after he omitted the cantharides, he made but twelve pints of water, but on the next day this good effect ceaſed again.

November 21.—He made eighteen pints of water, and he now, at Dr. Darwin's requeſt, took a grain of opium every four hours, and five grains of aloes at night; and had a flannel ſhirt given him.

22.—Made ſixteen pints. 23.—Thirteen pints: drinks leſs.

24.—Increaſed the opium to a grain and quarter every four hours: he made twelve pints.

25.—Increaſed the opium to a grain and half: he now makes ten pints; and drinks eight pints in a day.

The opium was gradually increaſed during the next fortnight, till he took three grains every four hours, but without any farther dimunition of his water. During the uſe of the opium he ſweat much in the nights, ſo as to have large drops ſtand on his face and all over him. The quantity of opium was then gradually decreaſed, but not totally omitted, as he continued to take about a grain morning and evening.

January

January 17.—He makes fourteen pints of water a day. Dr. Underhill now directed him two fcruples of common refin triturated with as much fugar, every fix hours; and three grains of opium every night.

19.—Makes fifteen pints of water: fweats at night.

21.—Makes feventeen pints of water; has twitchings of his limbs in a morning, and pains of his legs: he now takes a dram of refin for a dofe, and continues the opium.

23.—Water more coloured, and reduced to fixteen pints, and he thinks has a brackifh tafte.

26.—Water reduced to fourteen pints.

28.—Water thirteen pints: he continues the opium, and takes four fcruples of the refin for a dofe.

February 1.—Water twelve pints.

4.—Water eleven pints: twitchings lefs; takes five fcruples for a dofe.

8.—Water ten pints: has had many ftools.

12.—Appetite lefs: purges very much.

After this the refin either purged him, or would not ftay on his ftomach; and he gradually relapfed nearly to his former condition, and in a few months funk under the difeafe.

October 3, Mr. Hughes evaporated two quarts of the water, and obtained from it four ounces and half of a hard and brittle faccharine mafs, like treacle which had been fome time boiled.

Four

Four ounces of blood, which he took from his arm with defign to examine it, had the common appearances, except that the ferum refembled cheefe-whey; and that on the evidence of four perfons, two of whom did not know what it was they tafted, *the ferum had a faltifh tafte.*

From hence it appears, that the faccharine matter, with which the urine of thefe patients fo much abounds, does not enter the blood-veffels like the nitre and afparagus mentioned above; but that the procefs of digeftion refembles the procefs of the germination of vegetables, or of making barley into malt; as the vaft quantity of fugar found in the urine muft be made from the food which he took (which was double that taken by others), and from the fourteen pints of fmall beer which he drank. And, fecondly, as the ferum of the blood was not fweet, the chyle appears to have been conveyed to the bladder without entering the circulation of the blood, fince fo large a quantity of fugar, as was found in the urine, namely, twenty ounces a day, could not have previoufly exifted in the blood without being perceptible to the tafte.

November 1. Mr. Hughes diffolved two drams of nitre in a pint of a decoction of the roots of afparagus, and added to it two ounces of tincture of rhubarb: the patient took a fourth part of this mixture every five minutes, till he had taken the whole.—In about half an hour he made eigh-

teen

teen ounces of water, which was very manifestly tinged with the rhubarb; the smell of asparagus was doubtful.

He then lost four ounces of blood, the serum of which was not so opake as that drawn before, but of a yellowish cast, as the serum of the blood usually appears.

Paper, dipped three or four times in the tinged urine and dried again, did not scintillate when it was set on fire; but when the flame was blown out, the fire ran along the paper for half an inch; which, when the same paper was unimpregnated, it would not do; nor when the same paper was dipped in urine made before he took the nitre, and dried in the same manner.

Paper, dipped in the serum of the blood and dried in the same manner as in the urine, did not scintillate when the flame was blown out, but burnt exactly in the same manner as the same paper dipped in the serum of blood drawn from another person.

This experiment, which is copied from a letter of Mr. Hughes, as well as the former, seems to evince the existence of another passage from the intestines to the bladder, in this disease, besides that of the sanguiferous system; and coincides with the curious experiment related in section the third, except that the smell of the asparagus was not here perceived, owing perhaps to the

roots

roots having been made ufe of inftead of the heads.

The rifing in the throat of this patient, and the twitchings of his limbs, feem to indicate fome fimilarity between the diabetes and the hyfteric difeafe, befides the great flow of pale urine, which is common to them both.

Perhaps if the mefenteric glands were nicely infpected in the diffections of thefe patients; and if the thoracic duct, and the larger branches of the lacteals, and if the lymphatics, which arife from the bladder, were well examined by injection, or by the knife, the caufe of diabetes might be more certainly underftood.

The opium alone, and the opium with the refin, feem much to have ferved this patient, and might probably have effected a cure, if the difeafe had been flighter, or the medicine had been exhibited, before it had been confirmed by habit during the feven months it had continued. The increafe of the quantity of water on beginning the large dofes of refin was probably owing to his omitting the morning dofes of opium.

As the urine in chyliferous diabetes abounds fo much with faccharine matter, as appears from the above cafe of Davis, Dr. Rollo has ingenioufly recommended a diet of animal food alone; this, with a diminution of the quantity of fluid, which the patient was previoufly accuftomed

cuſtomed to, is ſaid to have changed the quality of the urine, and to have diminiſhed its quantity. See Part II. Claſs I. 3. 2. 6. of this work.

### V. *The Phænomena of Dropſies explained.*

1. Some inebriates have their paroxyſms of inebriety terminated by much pale urine, or profuſe ſweats, or vomiting, or ſtools; others have their paroxyſms terminated by ſtupor, or ſleep, without the above evacuations.

The former kind of theſe inebriates have been obſerved to be more liable to diabetes and dropſy; and the latter to gout, gravel, and leproſy. Evoe! attend ye bacchanalians! ſtart at this dark train of evils, and amid your immodeſt jeſts, and idiot laughter, recollect,

Quem Deus vult perdere, prius dementat.

In thoſe who are ſubject to diabetes and dropſy, the abſorbent veſſels are naturally more irritable than in the latter; and by being frequently diſturbed or inverted by violent ſtimulus, and by their too great ſympathy with each other, they become at length either entirely paralytic, or are only ſuſceptible of motion from the ſtimulus of very acrid materials; as every part of the body, after having been uſed to great irritations, becomes leſs affected by ſmaller ones. Thus we cannot diſtinguiſh objects in the night,

for

for ſome time after we come out of a ſtrong light, though the iris is preſently dilated; and the air of a ſummer evening appears cold, after we have been expoſed to the heat of the day.

There are no cells in the body, where dropſy may not be produced, if the lymphatics ceaſe to abſorb that mucilaginous fluid, which is perpetually depoſited in them, for the purpoſe of lubricating their ſurfaces.

If the lymphatic branch, which opens into the cellular membrane, either does its office imperfectly, or not at all; theſe cells become replete with a mucilaginous fluid, which, after it has ſtagnated ſome time in the cells, will coagulate over the fire; and is erroneouſly called water. Wherever the ſeat of this diſeaſe is, (unleſs in the lungs or other pendent viſcera) the mucilaginous liquid above mentioned will ſubſide to the moſt depending parts of the body, as the feet and legs, when thoſe are lower than the head and trunk; for all theſe cells have communications with each other.

When the cellular abſorbents are become inſenſible to their uſual irritations, it moſt frequently happens, but not always, that the cutaneous branch of abſorbents, which is ſtrictly aſſociated with them, ſuffers the like inability. And then, as no water is abſorbed from the atmoſphere, the urine is not only leſs diluted at the time of its ſecretion, and conſequently in leſs

quantity

quantity and higher coloured: but great thirſt is at the ſame time induced, for as no water is abſorbed from the atmoſphere to dilute the chyle and blood, the lacteals and other abſorbent veſſels, which have not loſt their powers, are excited into more conſtant or more violent action, to ſupply this deficiency; whence the urine becomes ſtill leſs in quantity, and of a deeper colour, and turbid like the yolk of an egg, owing to a greater abſorption of its thinner parts. From this ſtronger action of thoſe abſorbents, which ſtill retain their irritability, the fat is alſo abſorbed, and the whole body becomes emaciated. This increaſed exertion of ſome branches of the lymphatics, while others are totally or partially paralytic, is reſembled by what conſtantly occurs in the hemiplegia; when the patient has loſt the uſe of the limbs on one ſide, he is inceſſantly moving thoſe of the other; for the moving power, not having acceſs to the paralytic limbs, becomes redundant in thoſe which are not diſeaſed.

The paucity of urine and thirſt cannot be explained from a greater quantity of mucilaginous fluid being depoſited in the cellular membrane: for though theſe ſymptoms have continued many weeks, or even months, this collection frequently does not amount to more than very few pints. Hence alſo the difficulty of promoting copious ſweats in anaſarca is accounted for, as well as the

great thirſt, paucity of urine, and loſs of fat; ſince, when the cutaneous branch of abſorbents is paralytic, or nearly ſo, there is already too ſmall a quantity of aqueous fluid in the blood: nor can theſe torpid cutaneous lymphatics be readily excited into retrograde motions.

Hence likewiſe we underſtand, why in the aſcites, and ſome other dropſies, there is often no thirſt, and no paucity of urine; in theſe caſes the cutaneous abſorbents continue to do their office.

Some have believed, that dropſies were occaſioned by the inability of the kidneys, from having only obſerved the paucity of urine; and have thence laboured much to obtain diuretic medicines; but it is daily obſervable, that thoſe who die of a total inability to make water, do not become dropſical in conſequence of it: Fernelius mentions one, who laboured under a perfect ſuppreſſion of urine during twenty days before his death, and yet had no ſymptoms of dropſy. Pathol. l. vi. c. 8. From the ſame idea many phyſicians have reſtrained their patients from drinking, though their thirſt has been very urgent; and ſome caſes have been publiſhed, where this cruel regimen has been thought advantageous: but others of nicer obſervation are of opinion, that it has always aggravated the diſtreſſes of the patient; and though it has abated his ſwellings, yet by inducing a fever it has

haſtened

hastened his dissolution. See Transactions of the College, London, vol. ii. p. 235. Cases of Dropsy by Dr. G. Baker.

The cure of anasarca, so far as respects the evacuation of the accumulated fluid, coincides with the idea of the retrograde action of the lymphatic system. It is well known that vomits, and other drugs, which induce sickness or nausea, at the same time that they evacuate the stomach, produce a great absorption of the lymph accumulated in the cellular membrane. In the operation of a vomit, not only the motions of the stomach and duodenum become inverted, but also those of the lymphatics and lacteals, which belong to them; whence a great quantity of chyle and lymph is perpetually poured into the stomach and intestines, during the operation, and evacuated by the mouth. Now at the same time, other branches of the lymphatic system, viz. those which open on the cellular membrane, are brought into more energetic action, by the sympathy above mentioned, and an increase of their absorption is produced.

Hence repeated vomits, and cupreous salts, and small doses of squill or foxglove, are so efficacious in this disease. And as drastic purges act also by inverting the motions of the lacteals; and thence the other branches of lymphatics are induced into more powerful natural action, by sympathy, and drink up the fluids from all the cells

of the body; and by their anaſtomoſes, pour them into the lacteal branches; which, by their inverted actions, return them into the inteſtines; and they are thus evacuated from the body:— theſe purges alſo are uſed with ſucceſs in diſcharging the accumulated fluid in anaſarca.

II. The following caſes are related with deſign to aſcertain the particular kinds of dropſy in which the digitalis purpurea, or common foxglove, is preferable to ſquill, or other evacuants, and were firſt publiſhed in 1780, in a pamphlet entitled Experiments on mucilaginous and purulent Matter, &c. Cadell. London. Other caſes of dropſy, treated with digitalis, were afterwards publiſhed by Dr. Darwin in the Medical Tranſactions, vol. iii. in which there is a miſtake in reſpect to the doſe of the powder of foxglove, which ſhould have been from five grains to one, inſtead of from five grains to ten.

*Anaſarca of the Lungs.*

1. A lady, between forty and fifty years of age, had been indiſpoſed ſome time, was then ſeized with cough and fever, and afterwards expectorated much digeſted mucus. This expectoration ſuddenly ceaſed, and a conſiderable difficulty of breathing ſupervened, with a pulſe very irregular both in velocity and ſtrength; ſhe was much diſtreſſed at firſt lying down, and at firſt riſing; but

but after a minute or two bore either of thofe attitudes with eafe. She had no pain or numbnefs in her arms; fhe had no hectic fever, nor any cold fhiverings, and the urine was in due quantity, and of the natural colour.

The difficulty of breathing was twice confiderably relieved by fmall dofes of ipecacuanha, which operated upwards and downwards, but recurred in a few days: fhe was then directed a decoction of foxglove, (digitalis purpurea) prepared by boiling four ounces of the frefh leaves from two pints of water to one pint; to which were added two ounces of vinous fpirit: fhe took three large fpoonfuls of this mixture every two hours, till fhe had taken it four times; a continued ficknefs fupervened, with frequent vomiting, and a copious flow of urine: thefe evacuations continued at intervals for two or three days, and relieved the difficulty of breathing.—She had fome relapfes afterwards, which were again relieved by the repetition of the decoction of foxglove.

2. A gentleman, about fixty years of age, who had been addicted to an immoderate ufe of fermented liquors, and had been very corpulent, gradually loft his ftrength and flefh, had great difficulty of breathing, with legs fomewhat fwelled, and a very irregular pulfe. He was very much diftreffed at firft lying down, and at firft rifing from his bed, yet in a minute or two was

eaſy in both theſe attitudes. He made ſtraw-coloured urine in due quantity, and had no pain or numbneſs of his arms.

He took a large ſpoonful of the decoction of foxglove, as above, every hour, for ten or twelve ſucceſſive hours, had inceſſant ſickneſs for about two days, and paſſed a large quantity of urine; upon which his breath became quite eaſy, and the ſwelling of his legs ſubſided; but as his whole conſtitution was already ſinking from the previous intemperance of his life, he did not ſurvive more than three or four months.

*Hydrops Pericardii.*

3. A gentleman of temperate life and ſedulous application to buſineſs, between thirty and forty years of age, had long been ſubject, at intervals, to an irregular pulſe: a few months ago he became weak, with difficulty of breathing, and dry cough. In this ſituation a phyſician of eminence directed him to abſtain from all animal food and fermented liquor, during which regimen all his complaints increaſed; he now became emaciated, and totally loſt his appetite; his pulſe very irregular both in velocity and ſtrength; with great difficulty of breathing, and ſome ſwelling of his legs; yet he could lie down horizontally in his bed, though he got little ſleep, and paſſed a due quantity of urine, and of the natural colour:

colour: no fullnefs or hardnefs could be perceived about the region of the liver; and he had no pain or numbnefs in his arms.

One night he had a moft profufe fweat all over his body and limbs, which quite deluged his bed, and for a day or two fomewhat relieved his difficulty of breathing, and his pulfe became lefs irregular: this copious fweat recurred three or four times at the intervals of five or fix days, and repeatedly alleviated his fymptoms.

He was directed one large fpoonful of the above decoction of foxglove every hour, till it procured fome confiderable evacuation: after he had taken it eleven fucceffive hours he had a few liquid ftools, attended with a great flow of urine, which laft had a dark tinge, as if mixed with a few drops of blood: he continued fick at intervals for two days, but his breath became quite eafy, and his pulfe quite regular, the fwelling of his legs difappeared, and his appetite and fleep returned.

He then took three grains of white vitriol twice a day, with fome bitter medicines, and a grain of opium with five grains of rhubarb every night; was advifed to eat flefh meat, and fpice, as his ftomach would bear it, with fmall beer, and a few glaffes of wine; and had iffues made in his thighs; and has fuffered no relapfe.

4. A lady, about fifty years of age, had for fome weeks great difficulty of breathing, with

very irregular pulſe, and conſiderable general debility: ſhe could lie down in bed, and the urine was in due quantity and of the natural colour, and ſhe had no pain or numbneſs of her arms.

She took one large ſpoonful of the above decoction of foxglove every hour, for ten or twelve ſucceſſive hours; was ſick, and made a quantity of pale urine for about two days, and was quite relieved both of the difficulty of breathing, and the irregularity of her pulſe. She then took a grain of opium, and five grains of rhubarb, every night, for many weeks; with ſome ſlight chalybeate and bitter medicines, and has ſuffered no relapſe.

### *Hydrops Thoracis.*

5. A tradeſman, about fifty years of age, became weak and ſhort of breath, eſpecially on increaſe of motion, with pain in one arm, about the inſertion of the biceps muſcle. He obſerved he ſometimes in the night made an unuſual quantity of pale water. He took calomel, alum, and peruvian bark, and all his ſymptoms increaſed: his legs began to ſwell conſiderably; his breath became more difficult, and he could not lie down in bed; but all this time he made a due quantity of ſtraw-coloured water.

The decoction of foxglove was given as in the preceding caſes, which operated chiefly by purg-

ing, and ſeemed to relieve his breath for a day or two; but alſo ſeemed to contribute to weaken him.—He became after ſome weeks univerſally dropſical, and died comatoſe.

6. A young lady of delicate conſtitution, with light eyes and hair, and who had perhaps lived too abſtemiouſly both in reſpect to the quantity and quality of what ſhe ate and drank, was ſeized with great difficulty of breathing, ſo as to threaten immediate death. Her extremities were quite cold, and her breath felt cold to the back of one's hand. She had no ſweat, nor could lie down for a ſingle moment; and had previouſly, and at preſent, complained of great weakneſs and pain and numbneſs of both her arms; had no ſwelling of her legs, no thirſt, water in due quantity and colour. Her ſiſter, about a year before, was afflicted with ſimilar ſymptoms, was repeatedly blooded, and died univerſally dropſical.

A grain of opium was given immediately, and repeated every ſix hours with evident and amazing advantage; afterwards a bliſter, with chalybeates, bitters, and eſſential oils, were exhibited, but nothing had ſuch eminent effect in relieving the difficulty of breathing and coldneſs of her extremities as opium, by the uſe of which in a few weeks ſhe perfectly regained her health, and has ſuffered no relapſe.

*Ascites.*

7. A young lady of delicate conſtitution having been expoſed to great fear, cold, and fatigue, by the overturn of a chaiſe in the night, began with pain and tumour in the right hypochondrium: in a few months a fluctuation was felt throughout the whole abdomen, more diſtinctly perceptible indeed about the region of the ſtomach; ſince the integuments of the lower part of the abdomen generally become thickened in this diſeaſe by a degree of anaſarca. Her legs were not ſwelled, no thirſt, water in due quantity and colour.—She took the foxglove ſo as to induce ſickneſs and ſtools, but without abating the ſwelling, and was obliged at length to ſubmit to the operation of tapping.

8. A man about ſixty-ſeven, who had long been accuſtomed to ſpirituous potation, had ſome time laboured under aſcites; his legs ſomewhat ſwelled; his breath eaſy in all attitudes; no appetite; great thirſt; urine in exceedingly ſmall quantity, very deep coloured, and turbid; pulſe equal. He took the foxglove in ſuch quantity as vomited him, and induced ſickneſs for two days; but procured no flow of urine, or diminution of his ſwelling; but was thought to leave him conſiderably weaker.

9. A corpulent man, accuſtomed to a large potation

potation of fermented liquors, had vehement cough, difficult breathing, anafarca of his legs, thighs, and hands, and confiderable tumour, with evident fluctuation of his abdomen; his pulfe was equal; his urine in fmall quantity, of deep colour, and turbid. Thefe fwellings had been twice confiderably abated by draftic cathartics. He took three ounces of a decoction of foxglove (made by boiling one ounce of the frefh leaves in a pint of water) every three hours, for two whole days; it then began to vomit and purge him violently, and promoted a great flow of urine; he was by thefe evacuations completely emptied in twelve hours. After two or three months all thefe fymptoms returned, and were again relieved by the ufe of the foxglove; and thus in the fpace of about three years he was about ten times evacuated, and continued all that time his ufual potations: excepting at firft, the medicine operated only by urine, and did not appear confiderably to weaken him.—The laft time he took it, it had no effect; and a few weeks afterwards he vomited a great quantity of blood, and expired.

## QUERIES.

1. As the firft fix of thefe patients had a due difcharge of urine, and of the natural colour, was not the feat of the difeafe confined to fome

part

part of the thorax, and the ſwelling of the legs rather a ſymptom of the obſtructed circulation of the blood, than of a paralyſis of the cellular lymphatics of thoſe parts?

2. When the original diſeaſe is a general anaſarca, do not the cutaneous lymphatics always become paralytic at the ſame time with the cellular ones, by their greater ſympathy with each other? and hence the paucity of urine, and the great thirſt, diſtinguiſh this kind of dropſy?

3. In the anaſarca of the lungs, when the diſeaſe is not very great, though the patients have conſiderable difficulty of breathing at their firſt lying down, yet after a minute or two their breath becomes eaſy again; and the ſame occurs at their firſt riſing. Is not this owing to the time neceſſary for the fluid in the cells of the lungs to change its place, ſo as the leaſt to incommode reſpiration in the new attitude?

4. In the dropſy of the pericardium does not the patient bear the horizontal or perpendicular attitude with equal eaſe? Does this circumſtance diſtinguiſh the dropſy of the pericardium from that of the lungs and of the thorax?

5. Do the univerſal ſweats diſtinguiſh the dropſy of the pericardium, or of the thorax? and thoſe, which cover the upper parts of the body only, the anaſarca of the lungs?

6. When in the dropſy of the thorax, the patient endeavours to lie down, does not the

extravaſated

extravaſated fluid compreſs the upper parts of the bronchia, and totally preclude the acceſs of air to every part of the lungs; whilſt in the perpendicular attitude the inferior parts of the lungs only are compreſſed? Does not ſomething ſimilar to this occur in the anaſarca of the lungs, when the diſeaſe is very great, and thus prevent thoſe patients alſo from lying down?

7. As a principal branch of the fourth cervical nerve of the left ſide, after having joined a branch of the third and of the ſecond cervical nerves, deſcending between the ſubclavian vein and artery, is received in a groove formed for it in the pericardium, and is obliged to make a conſiderable turn outwards to go over the prominent part of it, where the point of the heart is lodged, in its courſe to the diaphragm; and as the other phrenic nerve of the right ſide has a ſtraight courſe to the diaphragm; and as many other conſiderable branches of this fourth pair of cervical nerves are ſpread on the arms; does not a pain in the left arm diſtinguiſh a diſeaſe of the pericardium, as in the angina pectoris, or in the dropſy of the pericardium? and does not a pain or weakneſs in both arms diſtinguiſh the dropſy of the thorax?

8. Do not the dropſies of the thorax and pericardium frequently exiſt together, and thus add to the uncertainty and fatality of the diſeaſe?

9. Might

9. Might not the foxglove be ferviceable in hydrocephalus internus, in hydrocele, and in white fwellings of the joints?

## VI. *Of cold Sweats.*

There have been hiftories given of chronical immoderate fweatings, which bear fome analogy to the diabetes. Dr. Willis mentions a lady then living, whofe fweats were for many years fo profufe, that all her bed-clothes were not only moiftened, but deluged with them every night; and that many ounces, and fometimes pints, of this fweat, were received in veffels properly placed, as it trickled down her body. He adds, that fhe had great thirft, had taken many medicines, and fubmitted to various rules of life, and changes of climate, but ftill continued to have thefe immoderate fweats. Pharmac. ration. de fudore anglico.

Dr. Willis has alfo obferved, that the fudor anglicanus which appeared in England, in 1483, and continued till 1551, was in fome refpects fimilar to the diabetes; and as Dr. Caius, who faw this difeafe, mentions the vifcidity, as well as the quantity of thefe fweats, and adds, that the extremities were often cold, when the internal parts were burnt up with heat and thirft, with great and fpeedy emaciation and debility: there is great reafon to believe, that the fluids were

abforbed

abſorbed from the cells of the body by the cellular and cyſtic branches of the lymphatics, and poured on the ſkin by the retrograde motions of the cutaneous ones.

Sydenham has recorded, in the ſtationary fever of the year 1685, the viſcid ſweats flowing from the head, which were probably from the ſame ſource as thoſe in the ſweating plague above mentioned.

It is very common in dropſies of the cheſt or lungs to have the difficulty of breathing relieved by copious ſweats, flowing from the head and neck. Mr. P. about fifty years of age, had for many weeks been afflicted with anaſarca of his legs and thighs, attended with difficulty of breathing; and had repeatedly been relieved by ſquill, other bitters, and chalybeates.—One night the difficulty of breathing became ſo great, that it was thought he muſt have expired; but ſo copious a ſweat came out of his head and neck, that in a few hours ſome pints, by eſtimation, were wiped off from thoſe parts, and his breath was for a time relieved. This dyſpnœa and theſe ſweats recurred at intervals, and after ſome weeks he ceaſed to exiſt. The ſkin of his head and neck felt cold to the hand, and appeared pale at the time theſe ſweats flowed ſo abundantly; which is a proof, that they were produced by an inverted motion of the abſorbents of thoſe parts: for ſweats, which are the conſequence of an

increafed action of the fanguiferous fyftem, are always attended with a warmth of the fkin, greater than is natural, and a more florid colour; as the fweats from exercife, or thofe that fucceed the cold fits of agues. Can any one explain how thefe partial fweats fhould relieve the difficulty of breathing in anafarca, but by fuppofing that the pulmonary branch of abforbents drank up the fluid in the cavity of the thorax, or in the cells of the lungs, and threw it on the fkin, by the retrograde motions of the cutaneous branch? for, if we could fuppofe, that the increafed action of the cutaneous glands or capillaries poured upon the fkin this fluid, previoufly abforbed from the lungs; why is not the whole furface of the body covered with fweat? why is not the fkin warm? Add to this, that the fweats above mentioned were clammy or glutinous, which the condenfed perfpirable matter is not; whence it would feem to have been a different fluid from that of common perfpiration.

Dr. Dobfon, of Liverpool, has given a very ingenious explanation of the acid fweats, which he obferved in a diabetic patient—he thinks part of the chyle is fecreted by the fkin, and afterwards undergoes an acetous fermentation.—Can the chyle get thither, but by an inverted motion of the cutaneous lymphatics? in the fame manner as it is carried to the bladder, by the inverted motions of the urinary lymphatics. Medic. Obfervat. and Enq. London, vol. v.

Are

Are not the cold ſweats in ſome fainting fits, and in dying people, owing to an inverted motion of the cutaneous lymphatics? for in theſe there can be no increaſed arterial or glandular action.

Is the difficulty of breathing, ariſing from anaſarca of the lungs, relieved by ſweats from the head and neck; whilſt that difficulty of breathing, which ariſes from a dropſy of the thorax, or pericardium, is never attended with theſe ſweats of the head? and thence can theſe diſeaſes be diſtinguiſhed from each other? Do the periodic returns of nocturnal aſthma riſe from a temporary dropſy of the lungs, collected during their more torpid ſtate in ſound ſleep, and then re-abſorbed by the vehement efforts of the diſordered organs of reſpiration, and carried off by the copious ſweats about the head and neck?

More extenſive and accurate diſſections of the lymphatic ſyſtem are wanting to enable us to unravel theſe knots of ſcience.

### VII. *Tranſlations of Matter, of Chyle, of Milk, of Urine. Operation of purging Drugs applied externally.*

1. The tranſlations of matter from one part of the body to another, can only receive an explanation from the doctrine of the occaſional retrograde motions of ſome branches of the lymphatic ſyſtem:

ſyſtem: for how can matter, abſorbed and mixed with the whole maſs of blood, be ſo haſtily collected again in any one part? and is it not an immutable law, in animal bodies, that each gland can ſecrete no other, but its own proper fluid? which is, in part, fabricated in the very gland by an animal proceſs, which it there undergoes: of theſe purulent tranſlations innumerable and very remarkable inſtances are recorded.

2. The chyle, which is ſeen among the materials thrown up by violent vomiting, or in purging ſtools, can only come thither by its having been poured into the bowels by the inverted motions of the lacteals: for our aliment is not converted into chyle in the ſtomach or inteſtines by a chemical proceſs, but is made in the very mouths of the lacteals, or in the meſenteric glands; in the ſame manner as other ſecreted fluids are made by an animal proceſs in their adapted glands.

Here a curious phænomenon in the exhibition of mercury is worth explaining:—If a moderate doſe of calomel, as ſix or ten grains, be ſwallowed, and within one or two days a cathartic is given, a ſalivation is prevented: but after three or four days, a ſalivation having come on, repeated purges every day, for a week or two, are required to eliminate the mercury from the conſtitution. For this acrid metallic preparation, being abſorbed by the mouths of the lacteals, continues,

tinues for a time arreſted by the meſenteric glands, (as the variolous or venereal poiſons ſwell the ſubaxillar or inguinal glands): and, during the operation of a cathartic, is returned into the inteſtines by the inverted action of the lacteals, and thus carried out of the ſyſtem.

Hence we underſtand the uſe of vomits or purges, to thoſe who have ſwallowed either contagious or poiſonous materials, even though exhibited a day or even two days after ſuch accidents; namely, that by the retrograde motions of the lacteals and lymphatics, the material ſtill arreſted in the meſenteric, or other glands, may be eliminated from the body.

3. Many inſtances of milk and chyle found in ulcers are given by Haller, El. Phyſiol. t. vii. p. 12, 23, which admit of no other explanation than by ſuppoſing, that the chyle, imbibed by one branch of the abſorbent ſyſtem, was carried to the ulcer, by the inverted motions of another branch of the ſame ſyſtem.

4. Mrs. P. on the ſecond day after delivery, was ſeized with a violent purging, in which, though opiates, mucilages, the bark, and teſtacea were profuſely uſed, continued many days, till at length ſhe recovered. During the time of this purging, no milk could be drawn from her breaſts; but the ſtools appeared like the curd of milk broken into ſmall pieces. In this caſe, was not the milk taken up from the follicles of the

pectoral glands, and thrown on the inteftines, by a retrogreffion of the inteftinal abforbents? for how can we for a moment fufpect that the mucous glands of the inteftines could feparate pure milk from the blood? Dr. Smellie has obferved, that loofe ftools, mixed with milk, which is curdled in the inteftines, frequently relieves the turgefcency of the breafts of thofe who ftudioufly repel their milk. Cafes in Midwifery, 43, No. 2. 1.

5. J. F. Meckel obferved in a patient, whofe urine was in fmall quantity and high coloured, that a copious fweat under the arm-pits, of a perfectly urinous fmell, ftained the linen; which ceafed again when the ufual quantity of urine was difcharged by the urethra. Here we muft believe from analogy, that the urine was firft fecreted in the kidneys, then re-abforbed by the increafed action of the urinary lymphatics, and laftly carried to the axillæ by the retrograde motions of the lymphatic branches of thofe parts. As in the jaundice it is neceffary, that the bile fhould firft be fecreted by the liver, and re-abforbed into the circulation, to produce the yellownefs of the fkin; as was formerly demonftrated by the late Dr. Munro, (Edin. Medical Effays) and if in this patient the urine had been re-abforbed into the mafs of blood, as the bile in the jaundice, why was it not detected in other parts of the body, as well as in the arm-pits?

6. Cathartic

6. Cathartic and vermifuge medicines applied externally to the abdomen, ſeem to be taken up by the cutaneous branch of lymphatics, and poured on the inteſtines by the retrograde motions of the lacteals, without having paſſed the circulation.

For when the draſtic purges are taken by the mouth, they excite the lacteals of the inteſtines into retrograde motions, as appears from the chyle, which is found coagulated among the fæces, as was ſhewn above, (ſect. 2 and 4.) And as the cutaneous lymphatics are joined with the lacteals of the inteſtines, by frequent anaſtomoſes; it would be more extraordinary, when a ſtrong purging drug, abſorbed by the ſkin, is carried to the anaſtomoſing branches of the lacteals unchanged, if it ſhould not excite them into retrograde action as efficaciouſly, as if it was taken by the mouth, and mixed with the food of the ſtomach.

## VIII. *Circumſtances by which the Fluids, that are effuſed by the retrograde Motions of the abſorbent Veſſels, are diſtinguiſhed.*

1. WE frequently obſerve an unuſual quantity of mucus or other fluids in ſome diſeaſes, although the action of the glands, by which thoſe fluids are ſeparated from the blood, is not unuſually increaſed; but when the power of ab-

ſorption alone is diminiſhed. Thus the catarrhal humour from the noſtrils of ſome, who ride in froſty weather; and the tears, which run down the cheeks of thoſe, who have an obſtruction of the puncta lacrymalia; and the ichor of thoſe phagedenic ulcers, which are not attended with inflammation, are all inſtances of this circumſtance.

Theſe fluids however are eaſily diſtinguiſhed from others by their abounding in ammoniacal or muriatic ſalts; whence they inflame the circumjacent ſkin: thus in the catarrh the upper lip becomes red and ſwelled from the acrimony of the mucus, and patients complain of the ſaltneſs of its taſte. The eyes and cheeks are red with the corroſive tears, and the ichor of ſome herpetic eruptions erodes far and wide the contiguous parts, and is pungently ſalt to the taſte, as ſome patients have informed me.

Whilſt, on the contrary, thoſe fluids, which are effuſed by the retrograde action of the lymphatics, are for the moſt part mild and innocent; as water, chyle, and the natural mucus: or they take their properties from the materials previouſly abſorbed, as in the coloured or vinous urine, or that ſcented with aſparagus, deſcribed before.

2. Whenever the ſecretion of any fluid is increaſed, there is at the ſame time an increaſed heat in the part; for the ſecreted fluid, as the bile, did not previouſly exiſt in the maſs of blood,

1 but

but a new combination is produced in the gland. Now as ſolutions are attended with cold, ſo combinations are attended with heat; and it is probable the ſum of the heat given out by all the ſecreted fluids of animal bodies may be the cauſe of their general heat above that of the atmoſphere.

Hence the fluids derived from increaſed ſecretions are readily diſtinguiſhed from thoſe originating from the retrograde motions of the lymphatics: thus an increaſe of heat either in the diſeaſed parts, or diffuſed over the whole body, is perceptible, when copious bilious ſtools are conſequent to an inflamed liver; or a copious mucous ſalivation from the inflammatory angina.

3. When any ſecreted fluid is produced in an unuſual quantity, and at the ſame time the power of abſorption is increaſed in equal proportion, not only the heat of the gland becomes more intenſe, but the ſecreted fluid becomes thicker and milder, its thinner and ſaline parts being re-abſorbed: and theſe are diſtinguiſhable both by their greater conſiſtence, and by their heat, from the fluids, which are effuſed by the retrograde motions of the lymphatics; as is obſervable towards the termination of gonorrhœa, catarrh, chincough, and in thoſe ulcers, which are ſaid to abound with laudable pus.

4. When chyle is obſerved in ſtools, or among the materials ejected by vomit, we may be confi-

dent it must have been brought thither by the retrograde motions of the lacteals; for chyle does not previously exist amid the contents of the intestines, but is made in the very mouths of the lacteals, as was before explained.

5. When chyle, milk, or other extraneous fluids are found in the urinary bladder, or in any other excretory receptacle of a gland; no one can for a moment believe, that these have been collected from the mass of blood by a morbid secretion, as it contradicts all analogy.

——Aurea duræ
Mala ferant quercus? Narcisco floreat alnus?
Pinguia corticibus sudent electra myricæ?

Virgil.

## IX. *Retrograde Motions of Vegetable Juices.*

There are besides some motions of the sap in vegetables, which bear analogy to our present subject; and as the vegetable tribes are by many philosophers held to be inferior animals, it may be a matter of curiosity at least to observe, that their absorbent vessels seem evidently, at times, to be capable of a retrograde motion. Mr. Perault cut off a forked branch of a tree, with the leaves on; and inverting one of the forks into a vessel of water, observed, that the leaves on the other branch continued green much longer than those of a similar branch, cut off from

from the fame tree; which fhews, that the water from the veffel was carried up one part of the forked branch, by the retrograde motion of its veffels, and fupplied nutriment fome time to the other part of the branch, which was out of the water. And the celebrated Dr. Hales found, by numerous very accurate experiments, that the fap of trees rofe upwards during the warmer hours of the day, and in part defcended again during the cooler ones. Vegetable Statics.

It is well known that the branches of willows, and of many other trees, will either take root in the earth or ingraft on other trees, fo as to have their natural direction inverted, and yet flourifh with vigour.

Dr. Hope has alfo made this pleafing experiment, after the manner of Hales—he has placed a forked branch, cut from one tree, erect between two others; then cutting off a part of the bark from one fork applied it to a fimilar branch of one of the trees in its vicinity; and the fame of the other fork; fo that a tree is feen to grow fufpended in the air, between two other trees; which fupply their fofter friend with due nourifhment.

Miranturque novas frondes, et non fua poma.

All thefe experiments clearly evince, that the juices of vegetables can occafionally pafs either upwards or downwards in their abforbent fyftem of veffels.

 X. *Objections*

### X. *Objections answered.*

THE following experiment, at firſt view, would ſeem to invalidate this opinion of the retrograde motions of the lymphatic veſſels, in ſome diſeaſes.

About a gallon of milk having been given to a hungry ſwine, he was ſuffered to live about an hour, and was then killed by a ſtroke or two on his head with an axe.—On opening his belly the lacteals were well ſeen filled with chyle; on irritating many of the branches of them with a knife, they did not appear to empty themſelves haſtily; but they did however carry forwards their contents in a little time.

I then paſſed a ligature round ſeveral branches of lacteals, and irritated them much with a knife beneath the ligature, but could not make them regurgitate their contained fluid into the bowels.

I am not indeed certain, that the nerve was not at the ſame time included in the ligature, and thus the lymphatic rendered unirritable or lifeleſs; but this however is certain, that it is not any quantity of any ſtimulus, which induces the veſſels of animal bodies to revert their motions; but a certain quantity of a certain ſtimulus, as appears from wounds in the ſtomach, which do not produce vomiting; and wounds of the inteſtines, which do not produce the cholera morbus.

At

At Nottingham, a few years ago, two ſhoemakers quarrelled, and one of them with a knife, which they uſe in their occupation, ſtabbed his companion about the region of the ſtomach. On opening the abdomen of the wounded man after his death the food and medicines he had taken were in part found in the cavity of the belly, on the outſide of the bowels; and there was a wound about half an inch long at the bottom of the ſtomach; which I ſuppoſe was diſtended with liquor and food at the time of the accident; and thence was more liable to be injured at its bottom: but during the whole time he lived, which was about ten days, he had no efforts to vomit, nor ever even complained of being ſick at the ſtomach! Other caſes ſimilar to this are mentioned in the philoſophical tranſactions.

Thus, if you vellicate the throat with a feather, nauſea is produced; if you wound it with a penknife, pain is induced, but not ſickneſs. So if the ſoles of the feet of children or their armpits are tickled, convulſive laughter is excited, which ceaſes the moment the hand is applied, ſo as to rub them more forcibly.

The experiment therefore above related upon the lacteals of a dead pig, which were included in a ſtrict ligature, proves nothing; as it is not the quantity, but the kind of ſtimulus, which excites the lymphatic veſſels into retrograde motion.

XI. *The*

XI. *The Causes which induce the retrograde Motions of animal Vessels; and the Medicines by which the natural Motions are restored.*

1. Such is the construction of animal bodies, that all their parts, which are subjected to less stimuli than nature designed, perform their functions with less accuracy: thus, when too watery or too acescent food is taken into the stomach, indigestion, and flatulency, and heartburn succeed.

2. Another law of irritation, connate with our existence, is, that all those parts of the body, which have previously been exposed to too great a quantity of such stimuli, as strongly affect them, become for some time afterwards disobedient to the natural quantity of their adapted stimuli.—Thus the eye is incapable of seeing objects in an obscure room, though the iris is quite dilated, after having been exposed to the meridian sun.

3. There is a third law of irritation, that all the parts of our bodies, which have been lately subjected to less stimulus, than they have been accustomed to, when they are exposed to their usual quantity of stimulus, are excited into more energetic motions: thus when we come from a dusky cavern into the glare of daylight, our eyes are

are dazzled; and after emerging from the cold bath, the ſkin becomes warm and red.

4. There is a fourth law of irritation, that all the parts of our bodies, which are ſubjected to ſtill ſtronger ſtimuli for a length of time, become torpid, and refuſe to obey even theſe ſtronger ſtimuli; and thence do their offices very imperfectly.—Thus, if any one looks earneſtly for ſome minutes on an area, an inch diameter, of red ſilk, placed on a ſheet of white paper, the image of the ſilk will gradually become pale, and at length totally vaniſh.

5.° Nor is it the nerves of ſenſe alone, as the optic and auditory nerves, that thus become torpid, when the ſtimulus is withdrawn or their irritability decreaſed; but the motive muſcles, when they are deprived of their natural ſtimuli, or of their irritability, become torpid and paralytic; as is ſeen in the tremulous hand of the drunkard in a morning; and in the awkward ſtep of age.

The hollow muſcles alſo, of which the various veſſels of the body are conſtructed, when they are deprived of their natural ſtimuli, or of their due degree of irritability, not only become tremulous, as the arterial pulſations of dying people; but alſo frequently invert their motions, as in vomiting, in hyſteric ſuffocations, and diabetes above deſcribed.

I muſt beg your patient attention, for a few

moments, whilſt I endeavour to explain, how the retrograde actions of our hollow muſcles are the conſequence of their debility; as the tremulous actions of the ſolid muſcles are the conſequence of their debility. When, through fatigue, a muſcle can act no longer; the antagoniſt muſcles, either by their inanimate elaſticity, or by their animal action, draw the limb into a contrary direction: in the ſolid muſcles, as thoſe of locomotion, their actions are aſſociated in tribes, which have been accuſtomed to ſynchronous action only; hence when they are fatigued, only a ſingle contrary effort takes place; which is either tremulous, when the fatigued muſcles are again immediately brought into action; or it is a pandiculation, or ſtretching, where they are not immediately again brought into action.

Now the motions of the hollow muſcles, as they in general propel a fluid along their cavities, are aſſociated in trains, which have been accuſtomed to ſucceſſive actions: hence when one ring of ſuch a muſcle is fatigued from its too great debility, and is brought into retrograde action, the next ring from its aſſociation falls ſucceſſively into retrograde action; and ſo on throughout the whole canal. See Sect. XXV. 6.

6. But as the retrograde motions of the ſtomach, œſophagus, and fauces in vomiting are,

as it were, apparent to the eye; we ſhall conſider this operation more minutely, that the ſimilar operations in the more recondite parts of our ſyſtem may be eaſier underſtood.

From certain nauſeous ideas of the mind, from an ungrateful taſte in the mouth, or from fœtid ſmells, vomiting is ſometimes inſtantly excited; or even from a ſtroke on the head, or from the vibratory motions of a ſhip; all which originate from aſſociation, or ſympathy. See Sect. XX. on Vertigo.

But when the ſtomach is ſubjected to a leſs ſtimulus than is natural, according to the firſt law of irritation mentioned above, its motions become diſturbed, as in hunger; firſt pain is produced, then ſickneſs, and at length vain efforts to vomit, as many authors inform us.

But when a great quantity of wine, or of opium, is ſwallowed, the retrograde motions of the ſtomach do not occur till after ſeveral minutes, or even hours; for when the power of ſo ſtrong a ſtimulus ceaſes, according to the ſecond law of irritation, mentioned above, the periſtaltic motions become tremulous, and at length retrograde; as is well known to the drunkard, who on the next morning has ſickneſs and vomitings.

When a ſtill greater quantity of wine, or of opium, or when nauſeous vegetables, or ſtrong bitters,

bitters, or metallic ſalts, are taken into the ſtomach, they quickly induce vomiting; though all theſe in leſs doſes excite the ſtomach into more energetic action, and ſtrengthen the digeſtion; as the flowers of chamomile, and the vitriol of zinc: for, according to the fourth law of irritation, the ſtomach will not long be obedient to a ſtimulus ſo much greater than is natural; but its action becomes firſt tremulous and then retrograde.

7. When the motions of any veſſels become retrograde, leſs heat of the body is produced; for in paroxyſms of vomiting, of hyſteric affections, of diabetes, of aſthma, the extremities of the body are cold: hence we may conclude, that theſe ſymptoms ariſe from the debility of the parts in action; for an increaſe of muſcular action is always attended with increaſe of heat.

8. But as animal debility is owing to defect of ſtimulus, or to defect of irritability, as ſhewn above, the method of cure is eaſily deduced: when the vaſcular muſcles are not excited into their due action by the natural ſtimuli, we ſhould exhibit thoſe medicines, which poſſeſs a ſtill greater degree of ſtimulus; amongſt theſe are the fœtids, the volatiles, aromatics, bitters, metallic ſalts, opiates, wine, which indeed ſhould be given in ſmall doſes, and frequently repeated. To theſe ſhould be added conſtant, but moderate

exerciſe,

exercife, cheerfulnefs of mind, and change of country to a warmer climate; and perhaps occafionally the external ftimulus of blifters.

It is alfo frequently ufeful to diminifh the quantity of natural ftimulus for a fhort time, by which afterwards the irritability of the fyftem becomes increafed; according to the third law of irritation above mentioned, hence the ufe of baths fomewhat colder than animal heat, and of equitation in the open air.

*The catalogue of difeafes owing to the retrograde motions of lymphatics is here omitted, as it will appear in the fecond volume of this work. The following is the conclufion to this thefis of Mr.* CHARLES DARWIN.

THUS have I endeavoured in a concife manner to explain the numerous difeafes, which deduce their origin from the inverted motions of the hollow mufcles of our bodies: and it is probable, that Saint Vitus's dance, and the ftammering of fpeech, originate from a fimilar inverted order of the affociated motions of fome of the folid mufcles; which, as it is foreign to my prefent purpofe, I fhall not here difcufs.

I beg, illuftrious profeffors, and ingenious fellow-ftudents, that you will recollect how difficult

ficult a task I have attempted, to evince the retrograde motions of the lymphatic veſſels, when the veſſels themſelves for ſo many ages eſcaped the eyes and glaſſes of philoſophers: and if you are not yet convinced of the truth of this theory, hold, I entreat you, your minds in ſuſpenſe, till ANATOMY draws her ſword with happier omens, cuts aſunder the knots, which entangle PHYSIOLOGY; and, like an augur inſpecting the immolated victim, announces to mankind the wiſdom of HEAVEN.

ADDITION.

## ADDITION. Of Figure.

I feel myſelf much obliged by the accurate attention given to the firſt volume of Zoonomia, and by the ingenious criticiſms beſtowed on it, by the learned writers of that article both in the Analytical and Engliſh Reviews. Some circumſtances in which their ſentiments do not accord with thoſe expreſſed in the work, I intend to reconſider, and to explain further at ſome future time. One thing, in which both theſe gentlemen ſeem to diſſent from me, I ſhall now mention, it is concerning the manner, in which we acquire the idea of figure; a circumſtance of great importance in the knowledge of our intellect, as it ſhews the cauſe of the accuracy of our ideas of motion, time, ſpace, number, and of the mathematical ſciences, which are concerned in the menſurations or proportions of figure.

This I imagine may have in part ariſen from the prepoſſeſſion, which has almoſt univerſally prevailed, that ideas are immaterial beings, and therefore poſſeſs no properties in common with ſolid matter. Which I ſuppoſe to be a fanciful hypotheſis, like the ſtories of ghoſts and apparitions, which have ſo long amuſed, and ſtill amuſe the credulous without any foundation in nature.

The exiſtence of our own bodies, and of their

ſolidity, and of their figure, and of their motions, is taken for granted in my account of ideas; becauſe the ideas themſelves are believed to conſiſt of motions or configurations of ſolid fibres; and the queſtion now propoſed is, how we become acquainted with the figures of bodies external to our organs of ſenſe? Which I can only repeat from what is mentioned in Sect. XIV. 2. 2. that if part of an organ of ſenſe be ſtimulated into action, as of the ſenſe of touch, that part ſo ſtimulated into action muſt poſſeſs figure, which muſt be ſimilar to the figure of the body, which ſtimulates it.

Another previous prepoſſeſſion of the mind, which may have rendered the manner of our acquiring the knowledge of figure leſs intelligible, may have ariſen from the common opinion of the perceiving faculty reſiding in the head; whereas our daily experience ſhews, that our perception (which conſiſts of an idea, and of the pleaſure or pain it occaſions) exiſts principally in the organ of ſenſe, which is ſtimulated into action; as every one, who burns his finger in the candle, muſt be bold to deny.

When an ivory triangle is preſſed on the palm of the hand, the figure of the ſurface of the part of the organ of touch thus compreſſed is a triangle, reſembling in figure the figure of the external body, which compreſſes it. The action of the ſtimulated fibres, which conſtitute the idea

of hardneſs and of figure, remains in this part of the ſenſorium, which forms the ſenſe of touch; but the ſenſorial motion, which conſtitutes pleaſure or pain, and which is excited in conſequence of theſe fibrous motions of the organ of ſenſe, is propagated to the central parts of the ſenſorium, or to the whole of it; though this generally occurs in leſs degree of energy, than it exiſts in the ſtimulated organ of ſenſe; as in the inſtance above mentioned of burning a finger in the candle.

Some, who have eſpouſed the doctrine of the immateriality of ideas, have ſeriouſly doubted the exiſtence of a material world, with which only our ſenſes acquaint us; and yet have aſſented to the exiſtence of ſpirit, with which our ſenſes cannot acquaint us; and have finally allowed, that all our knowledge is derived through the medium of our ſenſes! They forget, that if the ſpirit of animation had no properties in common with matter, it could neither affect nor be affected by the material body. But the knowledge of our own material exiſtence being granted, which I ſuſpect few rational perſons will ſeriouſly deny, the exiſtence of a material external world follows in courſe; as our perceptions, when we are awake and not inſane, are diſtinguiſhed from thoſe excited by ſenſation, as in our dreams, and from thoſe excited by volition or by aſſociation, as in inſanity and reverie, by the power we have

of

of comparing the preſent perceptions of one ſenſe with thoſe of another, as explained in Sect. XIV. 2. 5. And alſo by comparing the tribes of ideas, which the ſymbols of pictures, or of languages, ſuggeſt to us, by intuitive analogy with our previous experience, that is, with the common courſe of nature. See Claſs III. 2. 2. 3. on Credulity.

END OF THE FIRST VOLUME.

T. Bensley, Printer, Bolt Court, Fleet Street, London.